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Inspection Manual for the Enforcement of New Source Performance Standards Coal Preparation Plants

PEDCo-Environmental, Inc, Cincinnati, Ohio

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INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS

COAL PREPARATION PLANTS

U.S. ENVIRONMENTAL PROTECTION AGENCY
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Office of General Enforcement
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Standards of Performance for new and modified coal preparation plants were promulgated under Section 111 of the Clean Air Act on January 15, 1976. This report presents procedures for inspection of coal preparation facilities toward determination of their compliance with NSPS. It also provides background information that will aid the inspector in understanding the coal preparation process and the effects of operating parameters on process emissions.

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EPA Project Officer: Mark Antell

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1.0 INTRODUCTION

On October 24, 1974, under Section 111 of the Clean Air Act, as amended, the Environmental Protection Agency proposed standards of performance for new and modified coal preparation plants. The proposed standards were modified on the basis of comments received from various interested parties. The Federal Register of January 15, 1976, presents the standards of performance for new and modified coal preparation plants.

This report presents procedures for inspection of coal preparation facilities toward determination of their compliance with New Source Performance Standards (NSPS). It also provides background information that will aid the inspector in understanding the coal preparation process and the effects of operating parameters on process emissions.

Section 2.0 deals with the emission regulations for the coal preparation industry, presenting a brief history of NSPS, a discussion of the need for modifications of the proposed standards, and a summary of emission regulations, including monitoring and recordkeeping requirements. Regulations of individual states pertaining to coal preparation plants are compared with the NSPS.

Background information on the coal preparation industry is presented in Section 3.0, which describes the purpose of coal preparation, market requirements, market trends, geographic location of plants, and the economics of coal preparation.

Section 4.0 describes the coal preparation process and the major process variations, outlining the function of process equipment, the potential emission points, and the emission control techniques currently in use in the coal preparation industry.

Instrumentation and record-keeping practices of the newer plants are discussed in Section 5.0.

Section 6.0 deals with emissions that occur during start-up, shutdown, and malfunction, with operational procedures for maintaining such emissions at or below the required levels.

Section 7.0 presents in detail the inspection procedure and check points for observation during performance tests. Test duration, operating conditions, and interpretation of instrument indications are discussed.

Section 8.0 outlines periodic inspection procedures and the relationship of periodic inspection data to those obtained in the initial performance test.

The NSPS as presented in the Federal Register are reproduced in Appendix A. Appendix B presents standard test procedures.

2.0 SUMMARY OF NSPS REGULATIONS

The following summary of New Source Performance Standards for coal preparation plants is given in a format corresponding to that used in the Federal Register, as reproduced in Appendix A. Regulations proposed by individual states are discussed briefly.

2.1 APPLICABILITY AND DESIGNATION OF AFFECTED FACILITY

Coal preparation plants processing less than 200 tons per day of coal are exempted by the NSPS. The affected facilities in the coal preparation plants processing more than 200 tons per day are thermal dryers, pneumatic coal cleaning equipment (air tables), coal processing and conveying equipment (including breakers and crushers), coal storage systems, and coal transfer and loading facilities.

2.2 DEFINITIONS

Underground mining operations are not considered part of the coal preparation process. Coal storage and transfer sources are governed by NSPS only if they form a part of the coal preparation facility; isolated coal storage and transfer stations are excluded. Open coal storage piles are excluded from the definition of coal storage systems.

2.3 EMISSION STANDARDS FOR PARTICULATE MATTER

Regulations for emissions of particulate matter from coal processing facilities are as follows:

2.3.1 Thermal Dryer

Exhaust gases discharged into atmosphere shall not contain particulate matter in excess of 0.070 gram/dry standard cubic meter (g/dscm) or 0.031 grain/dry standard cubic foot (gr/dscf) and shall not exhibit 20 percent or greater opacity.

2.3.2 Pneumatic Coal Cleaning Equipment (Air Table)

The gases discharged into atmosphere from an air table shall not contain particulate matter in excess of 0.040 g/dscm (0.018 gr/dscf) and shall not exhibit 10 percent or greater opacity.

2.3.3 Other Facilities

The gases discharged into atmosphere from other coal conveying, processing, and storage and transfer facilities shall not exhibit 20 percent or greater opacity.

2.4 MONITORING OF OPERATIONS

The NSPS regulations require continuous monitoring of exit gas temperature on the thermal dryer. If a venturi scrubber is used to control emissions from the thermal dryer, continuous monitoring of water supply pressure and of pressure loss through the venturi constriction are required.

2.5 TEST METHODS AND PROCEDURES

The regulations prescribe standard test methods and procedures for particulate emission measurements. Method 5 is to be used for the concentration of particulate matter and associated moisture content, method 1 for sample and velocity traverse, method 2 for velocity and volumetric flow rate, and method 3 for gas analysis. The sampling time for method 5 is at least 60 minutes, and the minimum sample volume is 30.0 dscf. Sampling is not to be started until 30 minutes after start-up and is to be terminated before shutdown procedures commence. Standard test methods are given in Appendix B.

Most of the states have no separate emission regulations for coal preparation plants, which usually are encompassed under process emission regulations. Three eastern coal-producing states - Pennsylvania, Virginia, and West Virginia - and the State of New Mexico have formulated regulations for coal preparation plants.

The Pennsylvania regulations state a single allowable emission rate of 0.02 gr/dscf for thermal dryers and air tables. The concentration for thermal dryers is more stringent than the NSPS allowable concentration of 0.031 gr/dscf; the NSPS allowable emission rate for air tables is 0.018 gr/dscf. The Virginia regulations allow 105 pounds per hour of particulate emissions from thermal dryers processing 200 tons per hour or more coal. Allowable emissions from the air table are 0.05 gr/dscf. The West Virginia regulations for thermal dryers installed after March 1, 1970, range from 0.07 to 0.10 gr/dscf. Allowable emissions from an air table are 0.05 gr/dscf. New Mexico State regulations require good control of coal processing and conveying operations; no quantitative limits are specified. A comparison of NSPS regulations and these State regulations is presented in Table 2.1.

Table 2-1. NSPS AND STATE EMISSION REGULATIONS

Coal processing facility	NSPS	Particulate matter emission regulation				
		Pennsylvania	Virginia	West Virginia		New Mexico
				Gas flow, scfm	gr/dscf	
Thermal dryer	0.031 gr/dscf Opacity: less than 20 percent	0.020 gr/dscf	105 lb/hr	75,000 or less 111,000 or less 163,000 or less 240,000 or above	0.10 0.09 0.08 0.07	No regulation
Air table	0.018 gr/dscf Opacity: less than 10 percent	0.020 gr/dscf	0.05 gr/dscf	0.05 gr/dscf		No regulation
Processing and conveying	Opacity: less than 20 percent	No regulation	No regulation	Fugitive dust control system required		Fugitive dust control system required

3.0 COAL PREPARATION INDUSTRY

In the early part of this century efforts to prepare coal were directed to sizing the coal to supply lump coal for domestic use and intermediate sizes for industrial or bunker use; the fines were usually rejected as unfit for sale. Development of sizing facilities to meet the demands of the midcentury coal consumer resulted in highly sophisticated handling and screening facilities. Today's market requires less sizing than ever before, the primary limitation being maximum size for shipment.

Since the very early days of mining, attempts have been made to improve the quality of coal by removing slate. These efforts were made in the underground mines until the advent of mechanical mining, supported by hand picking in the "tipple" outside the mine. The first washing was done in Baum and Norton jigs imported from Europe, followed by the introduction of the "Chance" washer in 1918. The latter was an excellent washer utilizing sand and water as a medium, which has since been displaced by the "heavy media" process using magnetite. Through the years, many other types of washers have been introduced and have been abandoned.

The means of drying have been improved, although the original screening equipment has been supplemented only by centrifuges.

The adoption of Diester tables near the middle of the century to wash fine coal required supplementary equipment including centrifuges, froth flotation devices, disc filters, thickeners, cyclones, and thermal dryers.

3.1 COAL MARKETS

Until the middle of the century the primary coal markets were domestic, transportation (rail and ship), metallurgical, and industrial. At present the primary coal markets are for utility and metallurgical use and for export. The utility market uses low-quality coals. The metallurgical market requires the very best coals, completely prepared. The export market utilizes a quality somewhat lower than that of the metallurgical coals.

3.2 PURPOSE OF COAL PREPARATION

Coal preparation serves several purposes. One important purpose is to increase the heating value of the coal by mechanical removal of impurities. This is often required in order to find a market for the product. Run-of-mine coal from a modern mine may incorporate as much as 60 percent reject materials.

Air pollution control often requires partial removal of pyrites with the ash to reduce the sulfur content of the coal. Ash content often must be controlled to conform to a prescribed quality stipulated in contractual agreements. Because of firing characteristics, it is often as important to retain the ash content at a given level as it is to reduce it.

Freight savings are substantial when impurities are removed prior to loading. Finally, the rejected impurities are more easily disposed of at the mine site remote from cities than at the burning site, which is usually in a populated area.

3.3 DEVELOPMENT OF MINING METHODS AND CHANGING PREPARATION STANDARDS

The earliest mining system used in England, from which U.S. practices evolved, was the longwall method. Mining could proceed from the shaft only a short distance because no forced ventilation was available. All the coal within this perimeter was removed prior to extending the shaft deeper or sinking a new one. No coal preparation of consequence was performed at this time.

The room and pillar method was used in underground mines in this country because of the nature of and easy accessibility of the coal beds. Strip mining was introduced during the second decade of this century, after the development of the steam shovel for the Panama Canal, and the longwall system was reintroduced on an experimental basis during the last 20 years. Auger mining was introduced with the spread of coal stripping, as a supporting method of recoving coals from underneath a highwall.

Coal is produced currently by the following methods:

Underground mining		45 percent
Mined by hand	0.7	
Conventional mining	15.0	
Continuous mining	27.7	
Longwall mining	1.6	
Strip mining		55 percent

Until World War II most coal was loaded by hand and was obtained from the better seams of coal. Each worker was responsible for rejecting impurities and (sometimes) fines in the mine. Outside preparation equipment consisted of screens, crushers, and picking tables. Washeries were not common.

Exhaustion of the best coals and adoption of mechanical mining, which eliminated the removal of impurities in the mine, required the wider use of cleaning plants incorporating screens, crushers, picking tables, and washers. These plants normally practiced hand picking for the lump and egg sizes (more than 3 inches) and washed the coarser coal (3 in. x 1/4 in.). The fine coal (1/4 x 0) was usually shipped raw. The reject from such a plant was unlikely to exceed 10 percent of the run-of-mine (ROM) coal.

Introduction of the continuous miner requiring "full seam" mining, elimination of a large portion of the domestic market, and further exhaustion of the best coals imposed further requirements on the coal preparation plants. They were required to clean and dry the 1/4 x 0 coal fraction, the state of development that is current today. Picking tables have been eliminated, a fine-coal circuit has been added, and rejection of 50 percent of the ROM coal is not uncommon.

Fluctuations in coal demand resulted in the dismantling of plants, some of which were incorporated into other or new plants, always of larger capacities. The trend has been to utilize one large plant to process coal from several mines, even from different seams, at the expense of additional freight charges and intensified refuse disposal requirements. Figure 3-1 indicates the trends in the coal preparation industry.

Some plants, modified and expanded several times, are still operating at the original site after 50 years, long after the original mine has been abandoned.

3.4 LOCATION OF COAL PREPARATION PLANTS

General Considerations

Large coal washing plants are normally located in the mining areas to accommodate one or more mines. They are concentrated near the highest-quality coals because of process economics and market factors.

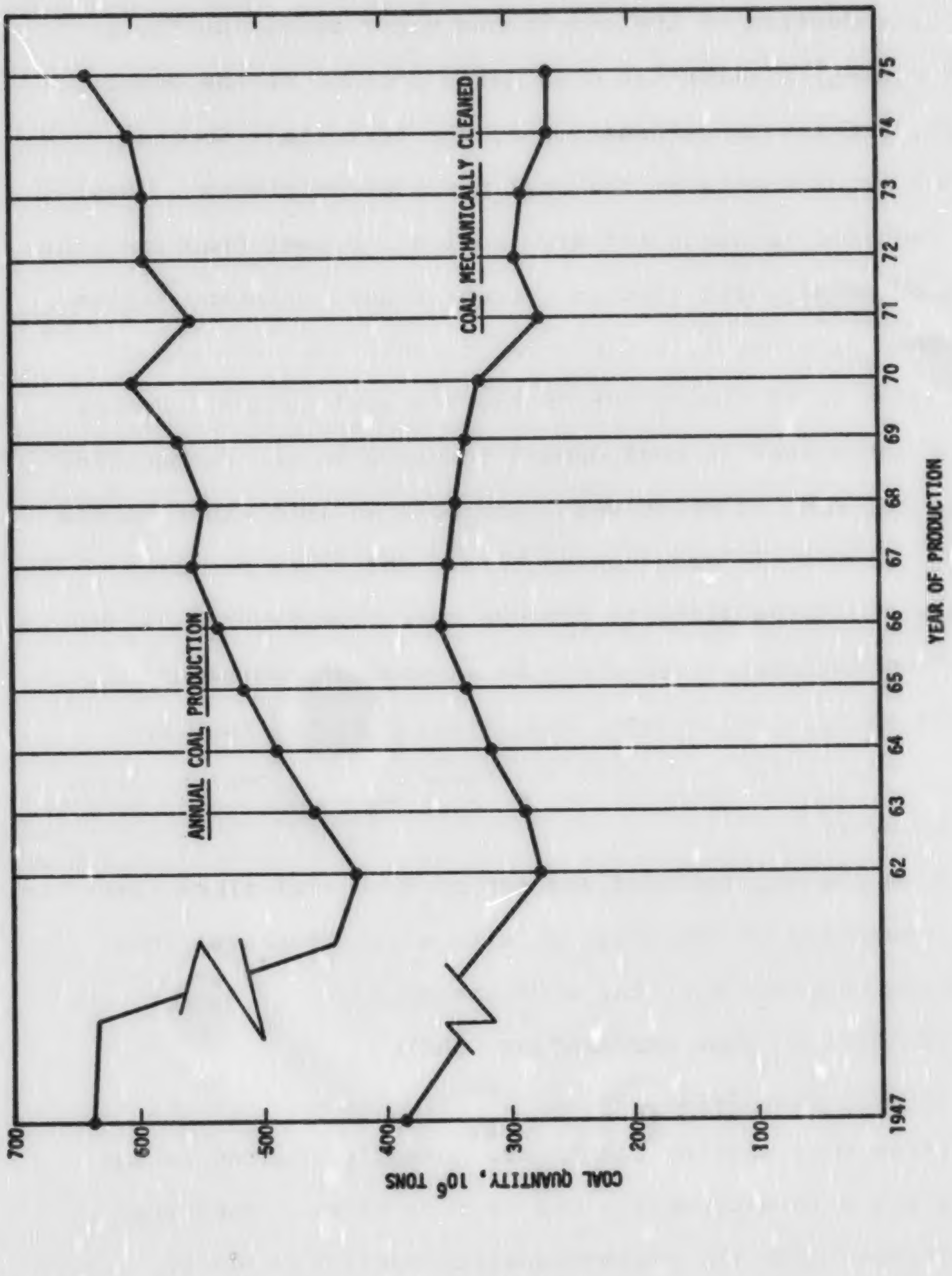


Figure 3-1. Trends in coal production and coal cleaning.

A few washing plants located at river loading sites are served by railroads with raw coal from the mines and dispose of the refuse near the plant.

Coal screening and crushing plants are sited at widely scattered locations wherever coal may be used, particularly at coke plants, coal yards, power plants, and industrial plants. They are also found at all mine loading sites. Table 3-1 gives locations of major plants.

Siting Considerations

Siting of coal preparation plants is based on the following considerations:

a. Length of haul. Optimum location is at shortest possible distance from the mine.

b. Access to transportation by railway or barge.

c. Water supply. The plant must be provided with substantial amounts of water from wells, streams, or impoundments.

d. Suitable terrain. Level areas are required for thickeners and slurry ponds; large areas must be suitable for refuse disposal.

Transportation of Raw Material

A shaft mine discharges coal directly into the plant without intermediate transportation.

Coal is also delivered directly from the mine by belt conveyor or mine cars when the plant is adjacent to the mine mouth.

Table 3-1. LOCATION OF COAL WASHING CAPACITY A
BITUMINOUS/LIGNITE COAL PRODUCTION

State	Production capacity 1974, thousand tons	No. operating companies	No. washing plants
Alabama	19,745	36	21
Alaska	716	1	
Arizona	6,432	1	
Arkansas	445	4	
Colorado	6,960	11	3
Illinois	58,080	14	36
Indiana	25,267	12	9
Iowa	680	7	
Kansas	679	2	2
Kentucky	133,000	338	69
Maryland	2,170	12	1
Missouri	4,625	3	2
Montana	14,089	5	
New Mexico	9,669	3	1
North Dakota	7,400	5	
Ohio	44,566	73	20
Oklahoma	2,375	7	
Pennsylvania	78,879	220	64
Tennessee	7,681	46	5
Texas	7,684	2	
Utah	6,047	10	5
Virginia	33,249	69	43
Washington	3,915	3	1
West Virginia	105,997	222	106
Wyoming	20,650	14	1
Total	601,000	1,120	389

Central cleaning plants are served by trucks, which may haul coal 20 miles from the mine, and by railcars, which haul raw coal to the plant and then reload with clean coal.

"Overland" conveyors haul coal from the mine to the plant over distances up to 10 miles. One installation moves coal from mine to plant by pipeline in a water medium.

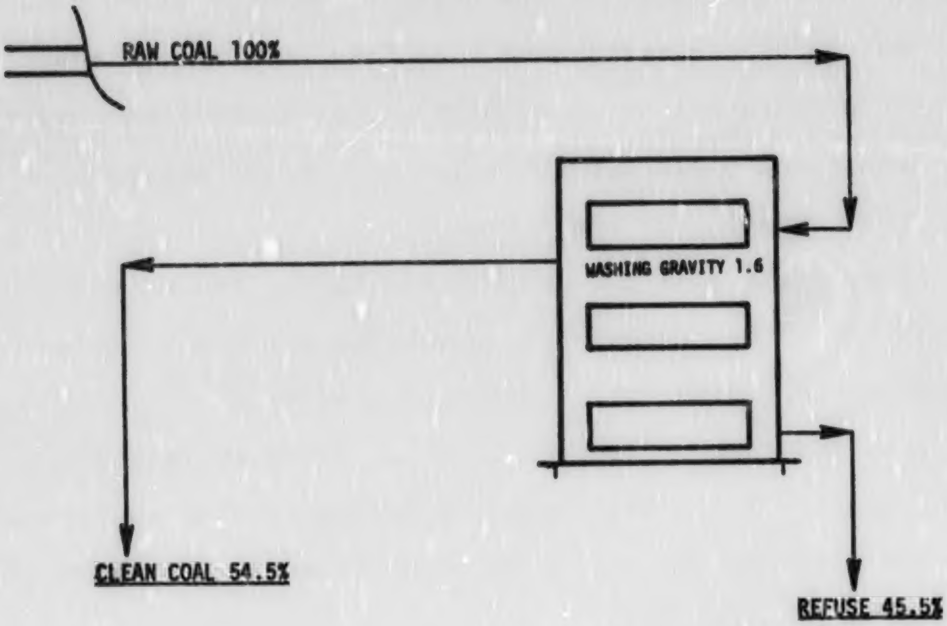
Transportation of Plant Products

Refuse from coal preparation usually is hauled to disposal areas by trucks. It is sometimes moved to adjacent valleys by belt conveyors and aerial tramways.

Prepared coal is removed from the plant by railway, barge, and truck. A small part is transported by conveyors to power plant stockpiles or to loading terminals for long-distance shipment.

3.5 ECONOMICS OF COAL PREPARATION

The advantages of preparing coal vary with the seam being mined, the type of mining, and potential markets. Figure 3-2 demonstrates the improvements made in the coal that could be mined from a coal seam by continuous miners in Indiana, Pennsylvania. This illustration represents an extreme case in coal mining and preparation. Large amounts of slate in the ROM material result in a heating value (HV) of 7580 Btu, which is too low for commercial sale. Rejection of impurities produces a product containing 6.6 percent ash



	%	HHV BTU/LB	% ASH	TOTAL HEAT CONTENT	% S
RAW COAL	100.0	7560	48.4	7560	5.0
CLEAN COAL	54.5	13308	6.6	7253	2.2
REFUSE	45.5	675	98.5	307	8.36

Figure 3-2. Illustrative cleaning circuit.

with a heating value of 13,300 Btu; such a coal is readily marketable.

The capacity of a boiler is upgraded by use of high-heat-content coal, offering indirect savings in capital investment, operation, and maintenance.

The sizes of stockpiles at large points of consumption are based on a required period of operation without replenishment. This requirement can be easily translated into a given amount of stored energy (Btu). Because a stockpile containing high-Btu coal can be smaller than one containing low-Btu coal, the costs of materials handling are lower. In the case depicted in Figure 3-2, a given stockpile of ROM coal would be 1.76 times larger than a pile of prepared coal having the same total heating value. Rejects from a cleaning plant are directly correlated to the ash produced in a power plant. The rejects from a cleaning plant are much easier to dispose of than is the ash from a power plant, and a substantial savings can be realized where disposal is done at the cleaning plant. A power plant using the coal evaluated in Fiqure 3-2 (45.5 percent reject) would be required to handle 7.24 times as much ash if the coal were burned raw rather than washed. Rejecting impurities at the mine results in a direct freight savings.

Two cases, illustrating use of raw and washed coal from the same mine, are analyzed in Table 3-2. Case 1 asseses the value of ROM coal that is shipped 200 miles to a power plant and sold for \$0.70/10^6 Btu. Case II assesses the value of the ROM coal that is washed and shipped to the same plant for the same price.

Coal preparation involves five different steps, combinations of which constitute the plant for a given mine.

Step 1 - Crushing/screening. This step involves no quality improvement, merely sizing for raw shipment. Most utility coal is prepared this way. If further preparation is involved, a separation is made at 1/4-3/8 inch.

This step includes all coal shipped. Costs are less than those of other steps, ranging from \$0.15 to \$0.30 per ton.

Step 2 - Wet washing the +1/4-inch sizes. Approximately 78 percent of all cleaned coal is washed by this means. Many plants use only this step, shipping the 1/4 x 0 size raw.

Cost of wet washing the +1/4-inch coal ranges from \$0.25 to \$0.50 per ton of feed.

Step 3 - Wet washing 1/4-inch x 28M (28 Mesh). Although not usually practiced elsewhere, this step is nearly always used at large underground mines. Approximately 14 percent of the cleaned coal is washed by this means.

Table 3-2. COST ANALYSIS, RAW AND WASHED COALS

Case I - Raw coal to power plant.[a]	
Purchase cost 1 ton $\left(\frac{2000 \times 7580 \text{ Btu} \times \$0.70}{10^6 \text{ Btu}}\right)$	= $10.61
Freight 200 miles (1 ton x 200 Mi. x $0.009[b])	= 1.80
Stockpile cost[c]	= 1.20
Ash disposal (45.5% x $3.80[c])	= 1.73
	$15.34
Actual cost of energy at bunker $\frac{\$15.34 \times 10^6}{2000 \times 7580} = \$1.01/10^6$ Btu	

Case II - Washed coal to power plant.	
Purchase cost 1 ton ROM $\left(\frac{2000 \times 13310 \times 0.545 \times 0.70}{10^6}\right)$	= $10.15
Freight 200 miles (0.545 x 200 x 0.009)	= 0.98
Washing cost	= 1.60[c]
Refuse disposal (0.455 x $1.20[c])	= 0.54
Stockpile cost (1.20 x 0.545)	= 0.65
Ash disposal (3.80 x 0.545 x 6.6%)	= 0.13
	$14.05
Actual cost of energy at bunker $\left(\frac{\$14.05 \times 10^6}{2000 \times 7253}\right) = \$0.97/10^6$ Btu	

[a] For this analysis the HV is below acceptable values. The price is below mining cost.

[b] Typical Midwest unit train rate, 200 MM ton mi/yr.

[c] Typical average cost.

Cost of this process ranges from $0.40 to $0.70 per ton of feed.

Dry cleaning of the 1/4 x 0 coal with air tables accounts for only 5 percent of all coal cleaned. It is sometimes accompanied by prethermal drying.

Cost of dry cleaning is between $0.20 and $0.40 per ton of feed. Thermal drying involves an additional cost.

Step 4 - Wet washing the 28M x 0, the least common method, is used with only 3 percent of the coal and is usually restricted to large deep mines equipped with continuous miners.

Costs range from $0.40 to $0.80 per ton of feed.

Step 5 - Thermal drying is nearly always restricted to 1/4 x 0 size coal, the exceptions being applications to predry coal for screening prior to cleaning on air tables.

Cost of drying ranges from $0.60 to $1.20 per ton of feed.

Costs for each step apply only to that portion of the feed that is affected, as indicated in Tables 3-3 and 3-4. Costs of coal preparation are dependent on screen analysis and amount of rejects as well as efficiency of operation and design/condition of plant.

The cost of processing in each step shown in the tables is the average of the cost ranges listed above. Table 3-3

Table 3-3. ILLUSTRATIVE PREPARATION COSTS,

EASTERN KENTUCKY COALS

Size	Percent of total coal	Cost, $/ton		Percent recovery	Percent of clean coal	Drying cost, $/ton	Cost of preparation, $/ton
		screening	washing				
Raw coal	100.0	0.225		100.0			0.225
+ 1/4 in.	51.1		0.375	75.0	38.3		0.191
1/4 x 28M	36.2		0.55	78.6	28.5	0.90	0.199) 0.256)
28M x 0	12.7		0.60	80.4	10.2	0.90	0.076) 0.090)
	100.0				77.0		1.037

Cost of preparation/ton of clean coal = $1.037 ÷ 0.77 = $1.34/ton portrays coal from eastern Kentucky mined by conventional methods; Table 3-4 portrays coal from southern West Virginia mined by continuous mining methods.

Table 3-4. ILLUSTRATIVE PREPARATION COSTS,

WEST VIRGINIA COALS

Size	Percent of total coal	Cost, $/ton		Recovery	Percent of clean coal	Drying cost, $/ton	Total preparation cost, $/ton
		screening	washing				
Raw coal	100.0	0.225		100.0			0.225
+ 1/4 in.	15.0		0.375	41.0	6.1		0.056
1/4 x 28M	65.7		0.55	68.1	44.7	0.90	0.361) 0.402)
28M x 0	19.3		0.60	69.1	13.4	0.90	0.116) 0.120)
	100.0				64.2		1.280

Cost of preparation/ton of clean coal = $1.28 ÷ 0.642 = $1.99/ton.

4.0 PROCESS DESCRIPTION

As it leaves the mine, coal varies widely in size, ash content, moisture content, and sulfur content. These are the characteristics that can be controlled by preparation.

Sizes range upward to that of foreign materials, such as a chunk of rock that has fallen from the mine roof or a metal tie; large pieces of coal from a very hard seam are sometimes included.

Ash content ranges from 3 to 60 percent at different mines. Most of the ash is introduced from the roof or bottom of the mine or from partings (small seams of slate) in the coal seam. This ash, called extraneous ash, is heavier than 1.80 specific gravity. The remaining ash is inherent in the coal. The density of the coal increases with the amount of ash present.

The moisture content of the coal is also of two types. The surface moisture, that which was introduced after the coal was broken loose from the seam, is the easier to remove. This moisture is introduced by exposure to air, wet mining conditions, rainfall (in stockpiles), and water sprays. The remaining moisture, called "bed", "cellular," or "inherent" moisture, can be removed only by coking or combustion. This moisture was included during formation of the coal.

Foreign materials are introduced into the coal during the mining process, the most common being roof bolts, ties, car wheels, timber, shot wires, and cutting bits.

Sulfur in coal occurs as sulfates, organic sulfur, and pyrites (sulfides of iron). The sulfates usually are present in small quantities and are not considered a problem. Organic sulfur is bound molecularly into the coal and is not removable by typical coal preparation processes. Pyrites generally are present in the form of modules or may be more intimately mixed with the coal. Coal preparation plants remove only a portion of the pyritic sulfur; therefore the degree of sulfur reduction depends on the percentage of pyrites in the coal, the degree to which this is intimately mixed with the coal, and extent of coal preparation.

All the materials described above are combined with the coal to form the run of mine (ROM) feed. Coal, as referred to above, denotes the portion of the feed that is desired for utilization.

4.1 CAPABILITIES OF COAL PREPARATION

Coal preparation processes can improve the ROM coal to meet market demands, as limited by the inherent characteristics of a given coal.

The top size of the ROM can be reduced to any size specified, although control of the varying size increments can be poor, dependent on the amount of crushing required. No practical technology is known for increasing the sizes of coal as mined.

All extraneous ash can be removed. The limiting factor for removal of the remainder is an economic one. The percentage of rejects of coal must not reach a point that precludes a profit on the operation. The coal from better seams can be processed to a reasonable ash content with few rejects. That from a poor seam will be unable to match the ash content without excessive losses. The optimum level of removing the inherent ash sometimes depends upon the percentage of the refuse material having specific gravities of 1.3 or lower.

Although inherent moisture cannot be changed, the surface moisture can be reduced to any level that is economically practicable. Considerations include the possibility of reexposure to moisture during shipment and subsequent storage and the fact that intense thermal drying creates ideal conditions for readsorption of moisture.

The free sulfur in the coal is subject to removal only by chemical treatment, which is not a coal preparation process, or by combustion. The reason that the pyrites can be partially removed in washing processes is that they are heavy enough to be removed with the ash. The processes can remove only 30 to 60 percent of the pyrites, however, because some pyrites are not broken free of the coal and are present in a given piece in a quantity too small to increase its weight enough to be rejected.

Foreign metals can be removed easily. Most wood fragments can be removed, although a few small pieces of wood cause no particular harm because they are combustible.

4.2 APPLICATION OF CLEANING PROCESSES TO SIZE INCREMENTS

Different types of mechanical cleaning apparatus are required for cleaning of coals in different size ranges. Coal larger than 8 inches is usually crushed to a smaller size; when lump coal is required, the large fraction is cleaned by slate pickers. The nominal size ranges and the applicable cleaning equipment are listed in Table 4-1.

Table 4-1. COAL SIZE RANGES FOR CLEANING EQUIPMENT

+ 8 inches	Picking tables
8 x 1/4	Heavy media bath or drums Jigs
1/4 x 48M	Diester tables Heavy media cyclones Air tables
48M x 0	Froth flotation

Use of thermal dryers is usually restricted to the two smaller size fractions. Occasionally the + 1/4-inch fraction is dried to permit screening.

4.3 COAL SIZING

The first operations performed on ROM coal are removal of tramp iron and reduction of size to permit mechanical processing. The schematic of coal sizing circuit is shown in Figure 4-1.

The ROM coal is first exposed to a high-intensity magnet, usually suspended over the incoming belt conveyor, which pulls the iron impurities out of the coal. This magnet sometimes follows the breaker but always precedes a screen-crusher.

The coal then goes to the breaker, which is a large cylindrical shell with interior lifting blades; the shell is perforated with holes (2- to 8-inch diameter) to permit passage of small material. The breaker rotates on a horizontal axis, receiving material in one end, tumbling it as it passes through, breaking the soft material (coal), which passes through the holes in the shell, and permitting the hard, large, unbroken material to pass out the rear. The small material (-4 inches) goes to the cleaning plant, and the large rejected material falls into a bin to be hauled away.

Various types of crushers are available for coal crushing. The hammermill, shown in Figure 4-2, and the rotary breaker, shown in Figure 4-3, are most commonly used.

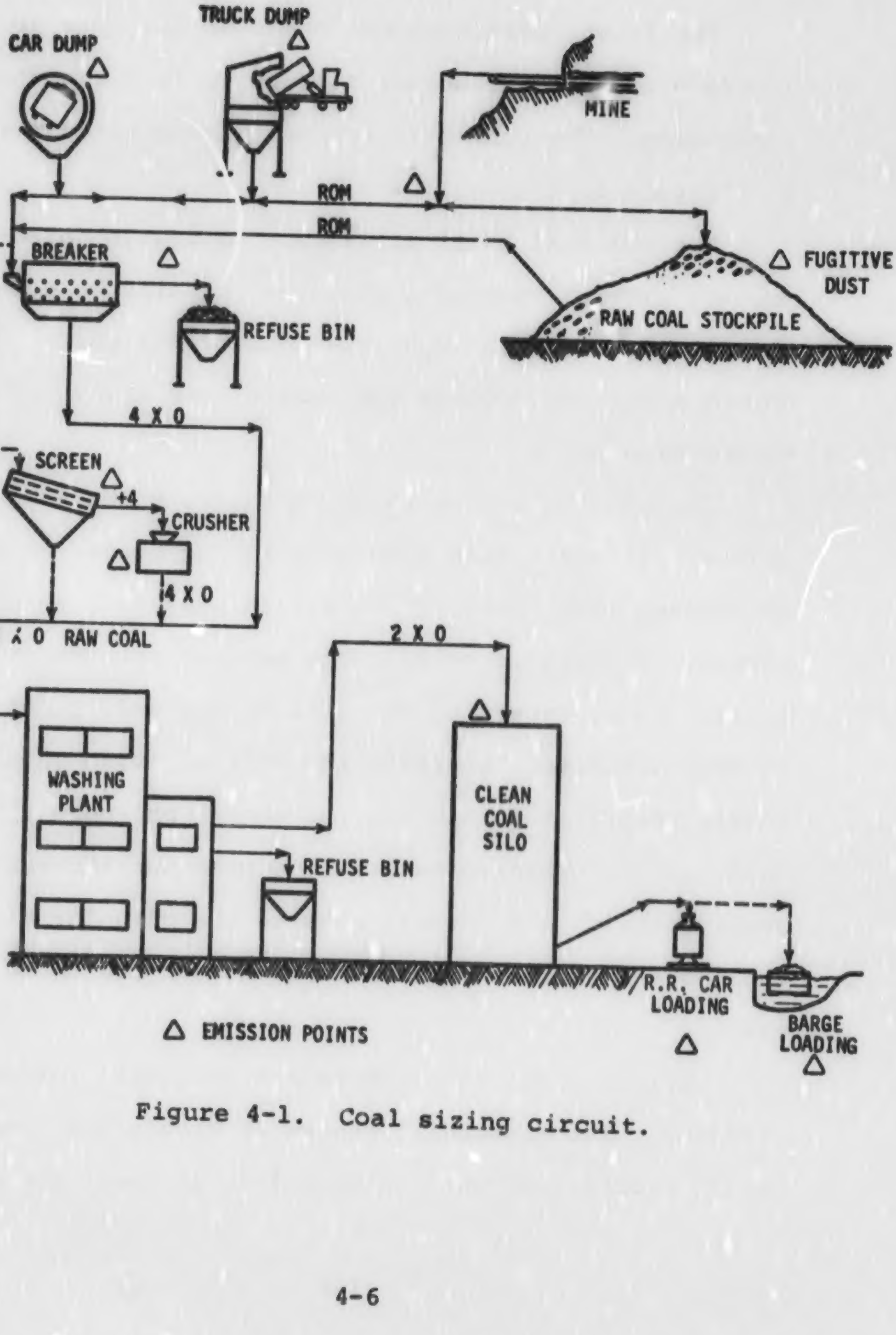


Figure 4-1. Coal sizing circuit.

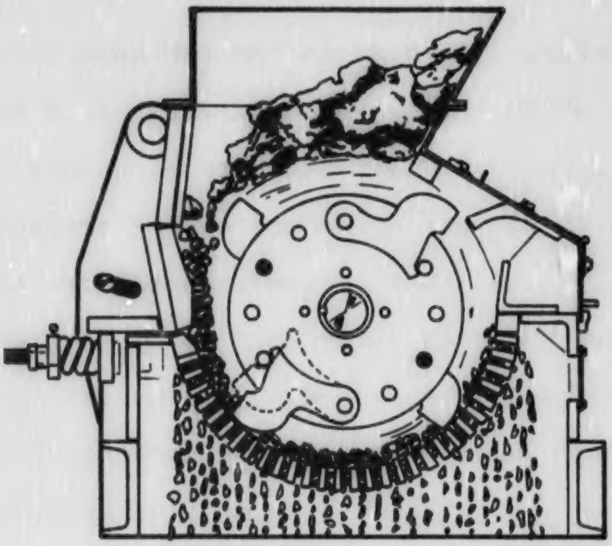


Figure 4-2. Hammermill.

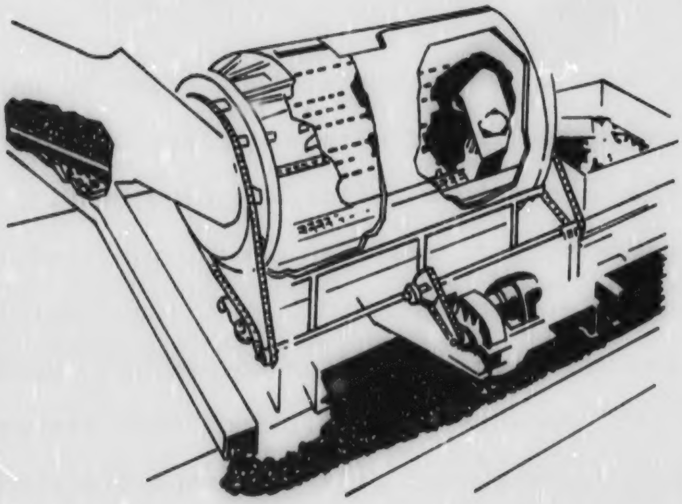


Figure 4-3. Rotary breaker.

An alternate flow directs the ROM coal to a scalping screen, from which the oversize material (+ 4 inches) falls to a crusher, where it is reduced to -4 inches and is recombined with the screen underflow for transportation to the cleaning plant. This system is used more than the breaker but is somewhat vulnerable to large pieces which pass through the crusher and must be removed in a later process. The crusher most commonly used for this purpose is a heavy-duty single roll with tramp iron protection.

Double rolls are more difficult to maintain in this heavy service, are more expensive, and offer no particular advantage. Slow-speed hammermills or impactors are more difficult to maintain, and jaw crushers have not been required.

The raw coal is sometimes stored, prior to washing, to allow optimum scheduling of mine and plant operations. Open storage is the most common; silos are also used.

At mines using unit train shipment, prepared coal is stored to accumulate enough to fill a train. For this purpose, silos are used most often to prevent accumulation of moisture and exposure to wind. Some open storage is also practiced. At other mines, cars or barges are loaded directly as the coal is processed, received, and shipped each day.

4.4 PNEUMATIC CLEANING

Pneumatic cleaning devices, or air tables, are applied to the small fractions (-3/8 inches). In these devices currents of air flow upward through a perforated bottom plate over which a layer of coal passes. The extreme fines are entrapped in the air and must be recaptured by cyclones and bag filters for return without quality improvement. As the coal reaches the end of the tables, the bottom layer is heavy (high-ash) material, a center layer is medium-weight coal and bone (high-ash), and the top layer is coal (low-ash). The middle layer must be incorporated with the refuse (and rewashed) or with the coal. A typical pneumatic cleaning circuit is shown in Figure 4-4. The cross-sectional view of an air table is shown in Figure 4-5.

The efficiency of these devices is poor. Their ability to remove ash is limited to 2 to 3 percent, regardless of how much is present. These devices represent the lowest capital investment of all cleaning devices, and they entail no problems of water supply and disposal.

The incoming coal must be screened, and, because feed to the tables must be dry, thermal drying of the raw feed is required at some plants. The thermal dryers, in turn, require cyclones and scrubbers for control of particulate emissions. Thermal dryers are fired with coal, oil, or gas.

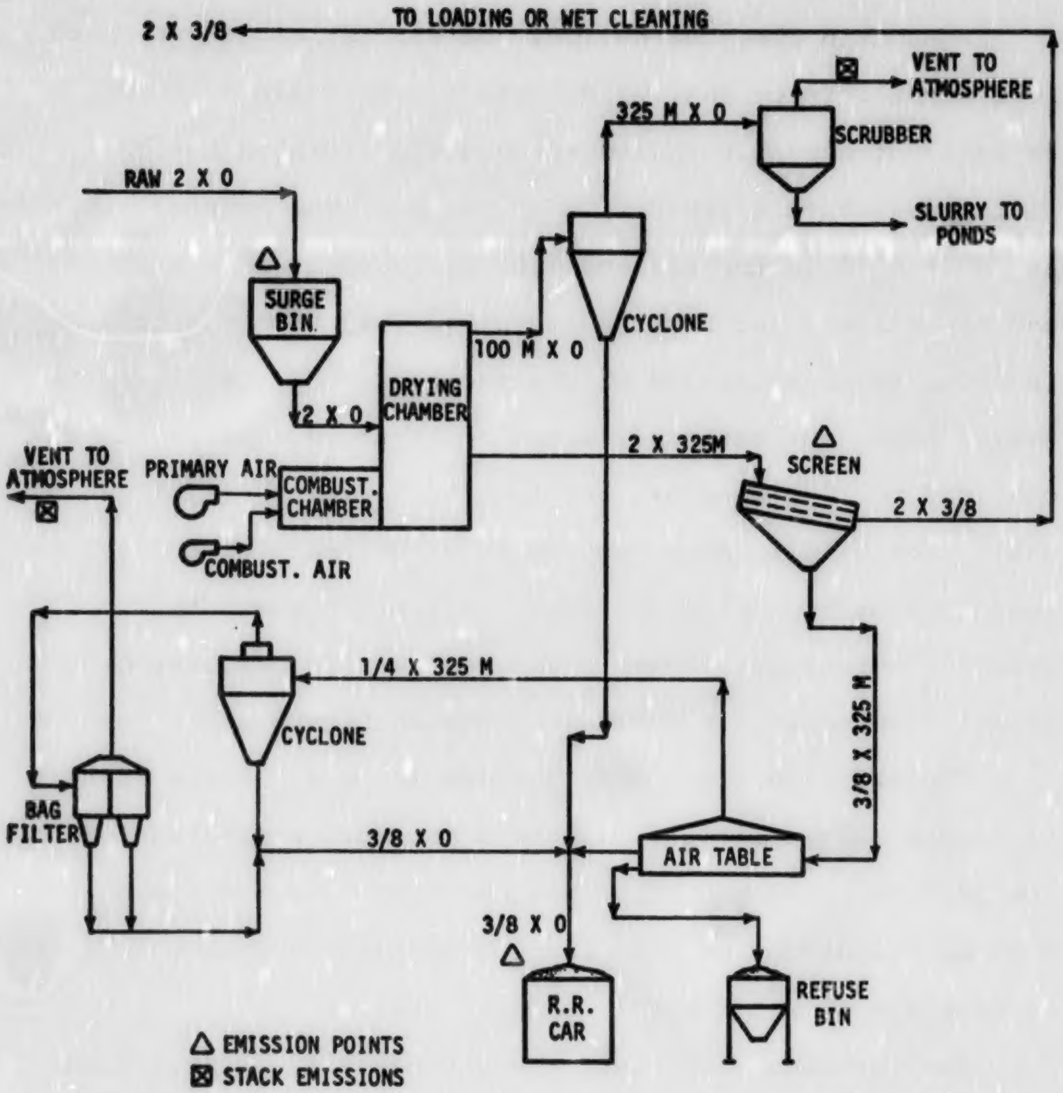


Figure 4-4. Pneumatic cleaning circuit.

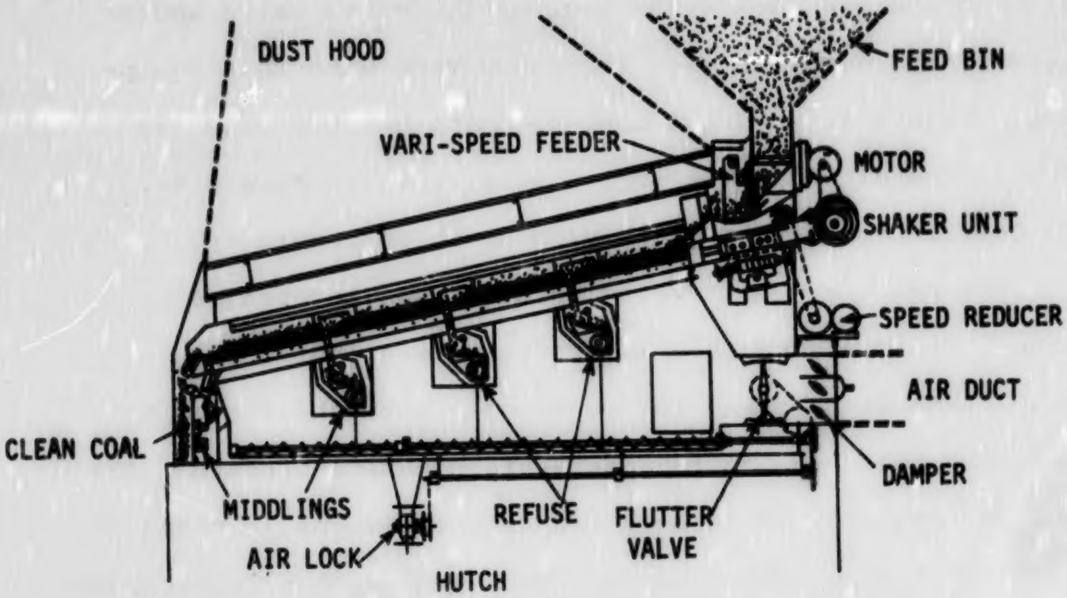


Figure 4-5. Air table.

4.5 JIG-TABLE WASHING

Jig-table washing plants are thus named because jigs are used to clean the +1/4-inch increment and Diester tables to clean the 1/4 inch x 28M increment. Froth cells and/or thermal dryers may be used in conjunction with this equipment. Figure 4-6 shows a coal cleaning circuit with jig table. The air-pulsated coal jig is shown in Figure 4-7, the Deister coal washing table is shown in Figure 4-8.

The raw coal, restricted to sizes smaller than 8 inches, is separated on a wet screen (usually 1/4-inch mesh). The large-sized increment goes into the jig; the remaining coal is sent to a separate cleaning circuit. The coal is dewatered on screens and in centrifuges, crushed to the desired size, and loaded. The jig makes the "equivalent" gravity separation on the principles of settling in rising and falling currents. The small-sized coal (-1/4 inch) is combined with the proper amount of water and distributed to the tables, where the refuse is separated from the coal. The refuse is dewatered on a screen and discarded. The clean coal is dewatered on a sieve bend (a stationary gravity screen), where the extreme fines are removed and discharged into a centrifuge for final dewatering and removal of the fines. The clean coal (+28M) is then loaded or conveyed to a thermal dryer. The Diester table is a

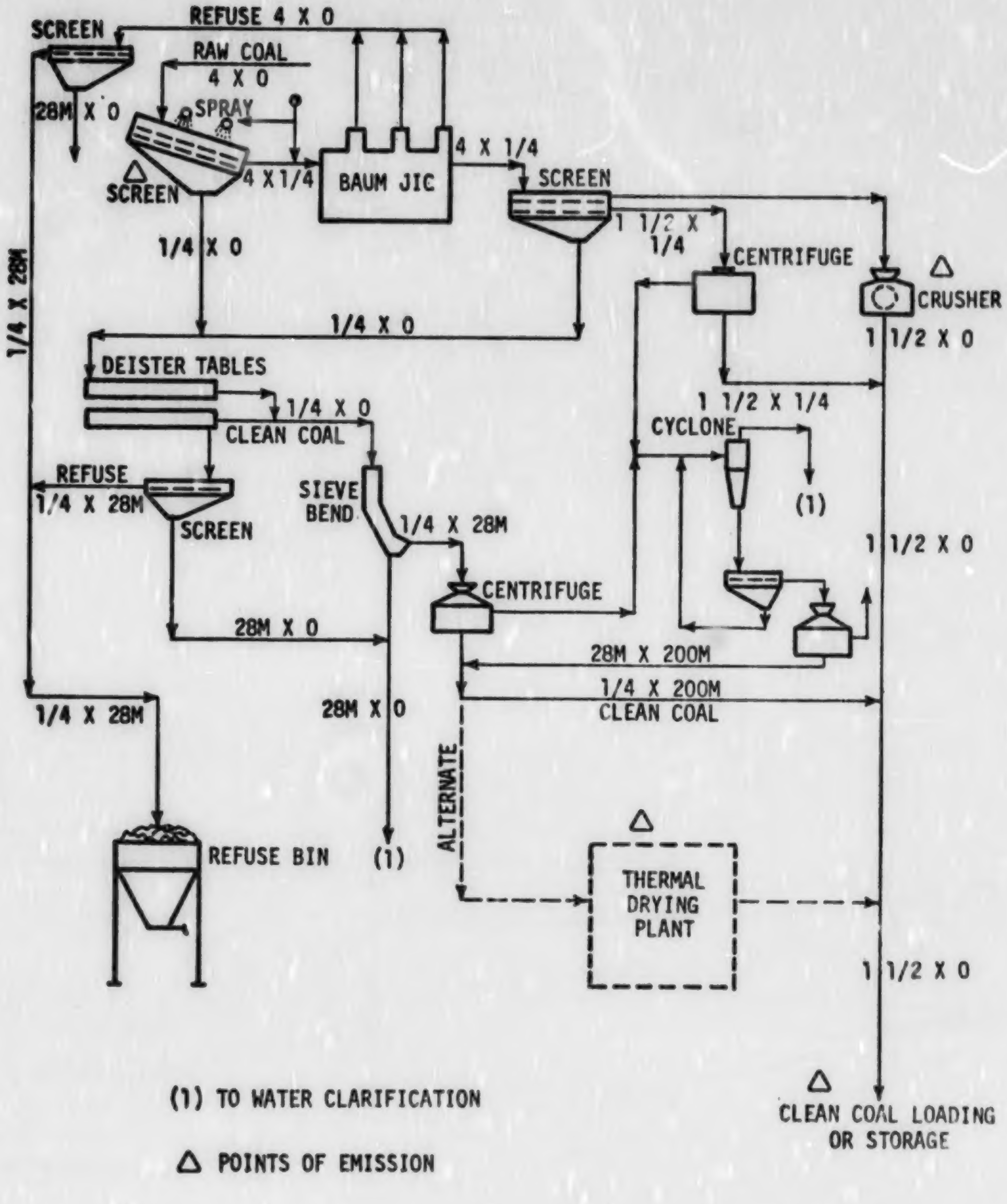


Figure 4-6. Jig table cleaning circuit.

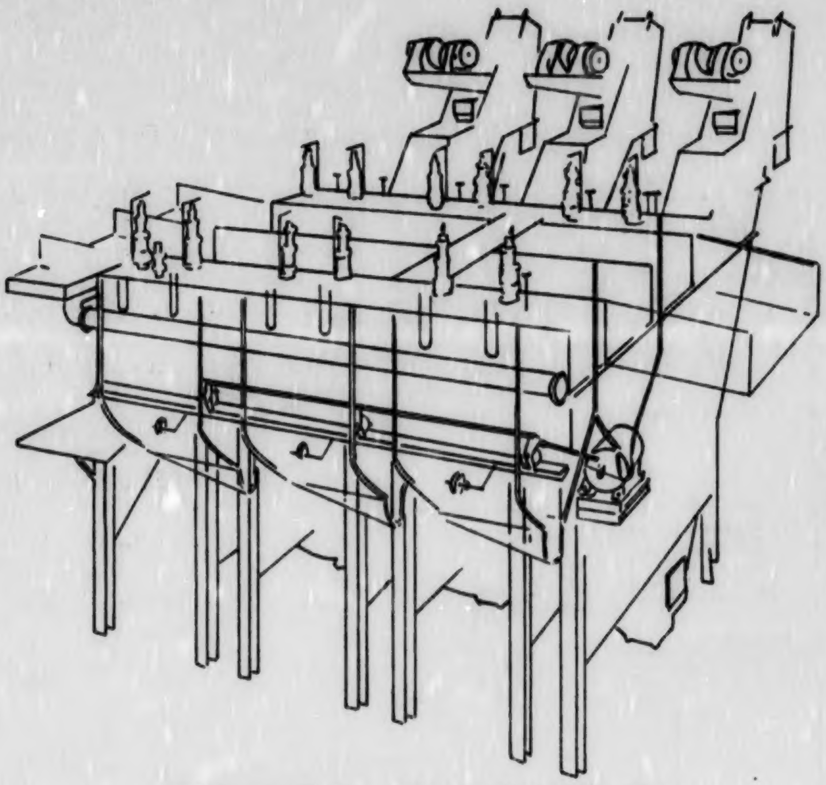


Figure 4-7. Air-pulsated jig.

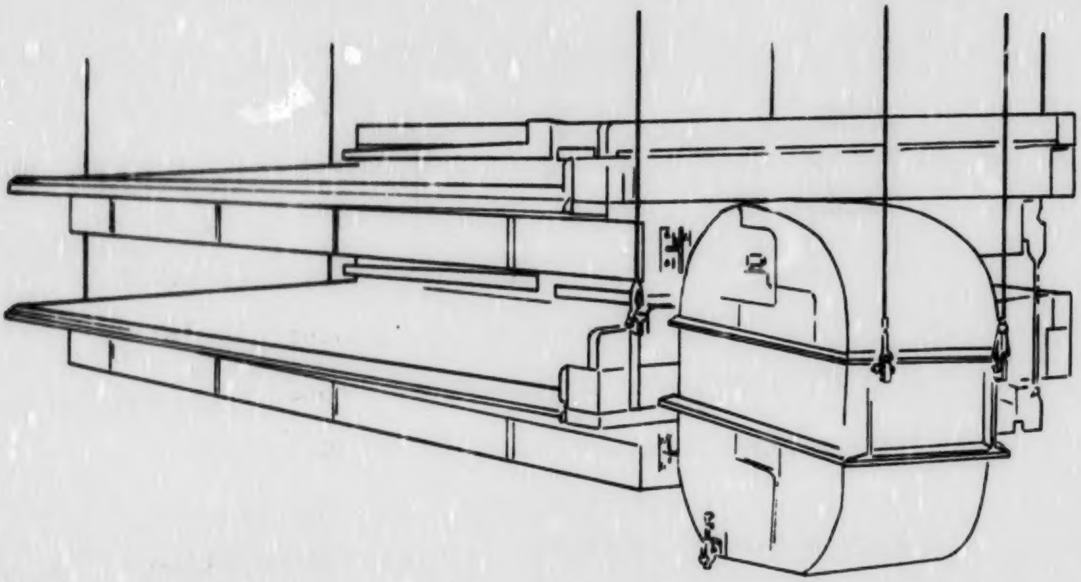


Figure 4-8. Deister table.

flat, "riffled" surface, approximately 12 feet square, which oscillates perpendicular to the "riffles," in the direction of the flow of coal. The heavy rejects are discharged off one end of the discharge side of the table, the light coal is discharged from the opposite end, and the "middlings" are distributed between.

The slurry produced, along with the fines, requires clarification before recirculation is feasible. Clarification is described in Section 4.7 and portrayed in Figure 4-11.

4.6 HEAVY-MEDIA WASHING PLANT

In a heavy-media washing plant, all the cleaning is done by flotation in a medium of selected specific gravity, maintained by a dispersion of finely ground magnetite in water. The plant is depicted in Figure 4-9. A schematic of a typical heavy-media cyclone is shown in Figure 4-10.

The incoming raw coal is separated at 1/4 inch on an inclined screen. The "overs" proceed to a flat "prewet" screen, where the fine dust particles are sprayed off from the +1/4-inch coal. This increment is discharged into a heavy-medium vessel or bath, where the refuse is separated from the coal. The refuse is discharged to a "refuse rinse" screen, where it is dewatered. The freed medium is divided into two parts, one returning directly to circulation via the heavy-medium sump and the other pumped to magnetite

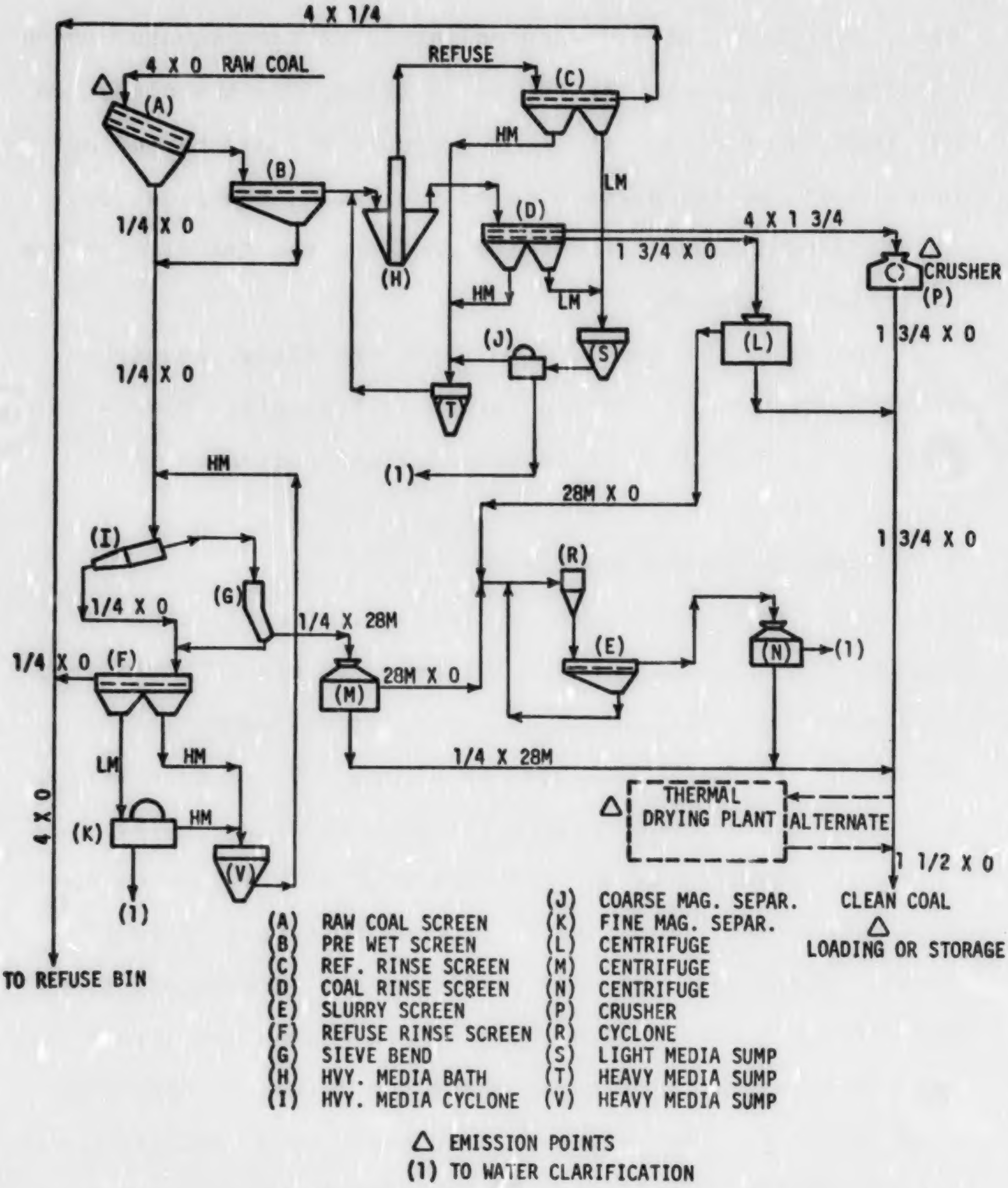


Figure 4-9. Heavy-media cleaning circuit.

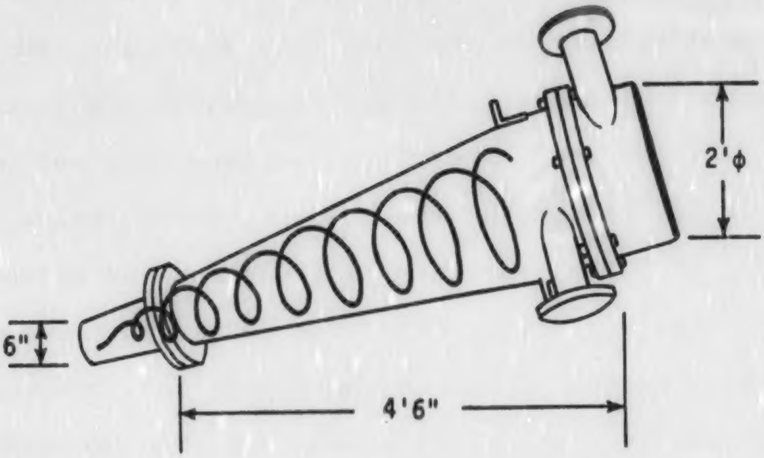


Figure 4-10. Heavy-media cyclone.

recovery. The refuse is discharged from the screen for disposal. The coal is discharged from the washer to a coal-rinse screen, where the coal is dewatered and the medium is treated as from the refuse screen. The clean coal is then centrifuged, crushed, and loaded. The fine coal (-1/4 inch) from the raw coal screens is combined with magnetite and water and pumped to a heavy-media cyclone, where the refuse is separated from the coal by cyclonic action. The medium for this use is different from the one used in the heavy-media vessel in that the magnetite is finer and the effective specific gravity is different. The refuse is dewatered and the medium is recovered, as in the coarse coal section. The coal is discharged over a sieve bend and then proceeds to a centrifuge for final dewatering prior to transfer to a thermal dryer or to loading.

Because the magnetite recovered from the rinse screens is diluted by sprays, it is processed in magnetic separators for recovery of the solid mineral. Each washer (bath and cyclone) retains its own recovery system, which includes sumps, pumps, and magnetic separators. The separator is a shaft-mounted steel drum containing an interior fixed magnet. The cylinder rotates within a vessel containing coal slurry and magnetite, retrieving solid magnetite from the slurry by virtue of the magnetic qualities of the magnetite and the magnetic field within the drum.

The effluent from the centrifuges contains -28M coal, broken from larger pieces of clean coal. This material is thickened in a cyclone, deslimed on a screen, and centrifuged prior to loading.

4.7 WATER CLARIFICATION PLANT

The water clarification plant receives all the slurry from the washing plant, separates the 48M x 0 fraction for cleaning, and returns the water for reuse. A typical clarification plant is shown in Figure 4-11. The 48M x 0 fraction flows to froth flotation cells, where it is mixed thoroughly with a reagent (light oil). The coal accepts a coating of oil and floats off the top of the liquid to a disc filter, where the excess water is drawn through a fabric by a vacuum. The water is recirculated to the washery, and the fine coal is transported to loading or to a dryer. Figure 4-12 shows the froth flotation unit.

The refuse does not accept the oil coating and sinks, to be removed with most of the incoming water to a static thickener. The thickener is a large, circular, open tank, which retains the water long enough to permit the particles of refuse to sink to the bottom. Clarified water is removed from the surface by "skimming troughs" around the perimeter of the tank and is recirculated to the cleaning plant.

The tank is equipped with a rotating rake, which rakes the fine refuse from the bottom of the tank to the center of

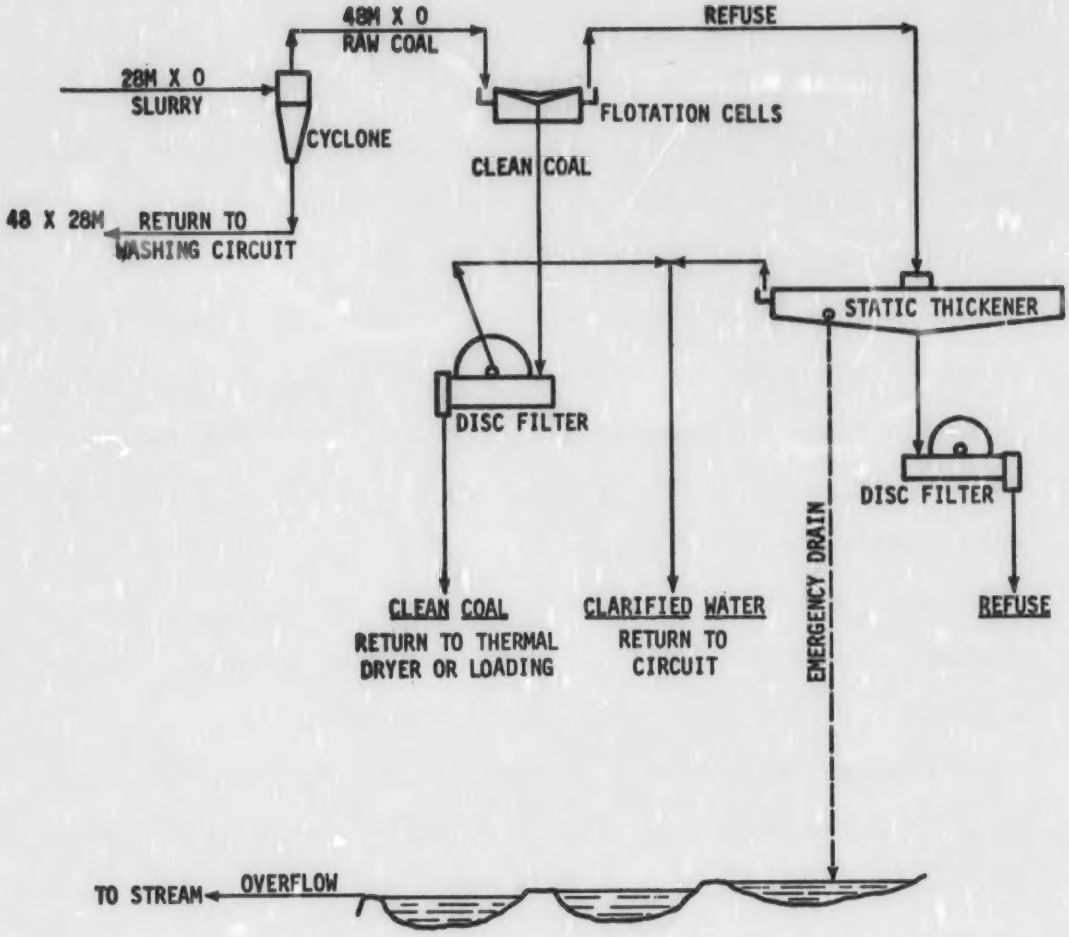


Figure 4-11. Water clarification circuit.

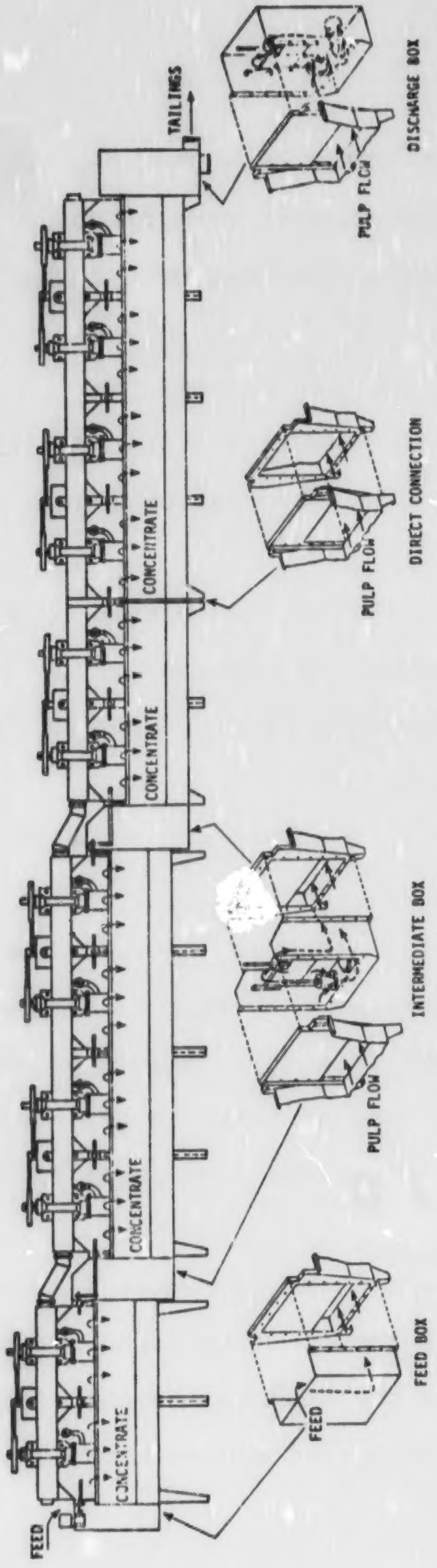


Figure 4-12. Froth flotation unit.

the tank, where it is collected by a pump and transferred to a disc filter. The filter removes part of the water for recirculation and discharges the solids as refuse.

4.8 THERMAL DRYING

The clean coal from various wet cleaning processes is wet and requires drying to make it suitable for transportation and final consumption. Thermal drying is employed to dry the wet coal.

Drying in the thermal dryer is achieved by a direct contact between the wet coal and currents of hot combustion gases. Various dryers marketed by different manufacturers work on the same basic principle.

The most common types of dryers are shown in Figures 4-13 through 4-16.

The fluid-bed dryer is shown in Figure 4-13. The dryer operates under negative pressure in which drying gases are drawn from the heat source through a fluidizing chamber. Dryer and furnace temperature controllers are employed in the control system to readjust the heat input to match the evaporative load changes.

The multilouver dryer, shown in Figure 4-14 is suitable for large volumes and for the coals requiring rapid drying. The coal is carried up in the flights and then flows downward in a shallow bed over the ascending flights. It gradu-

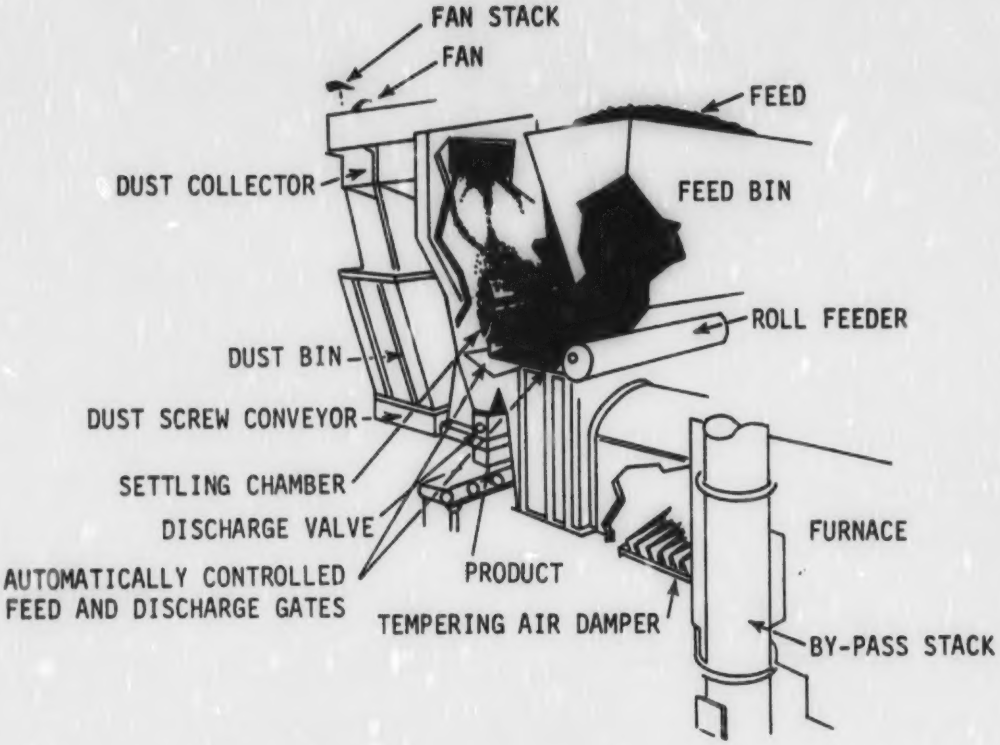


Table 4-13. Fluid-bed dryer.

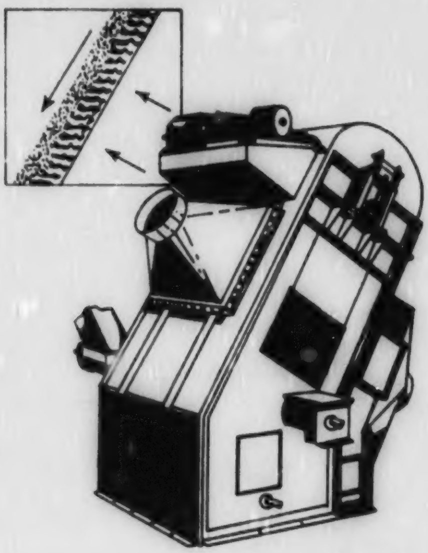


Figure 4-14. Multilouver dryer.

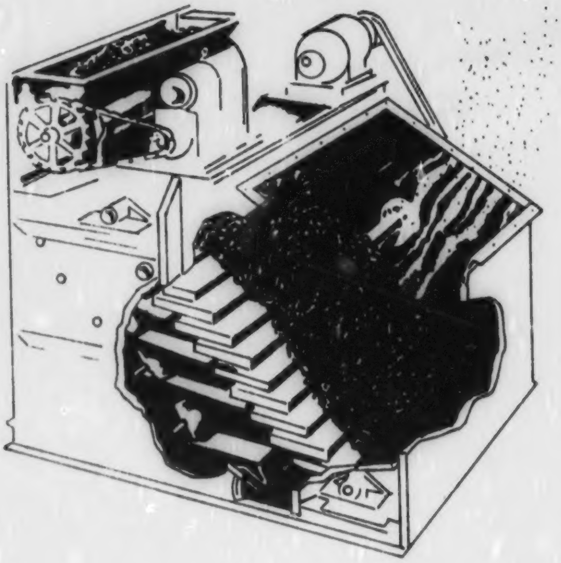


Figure 4-15. Cascade dryer.

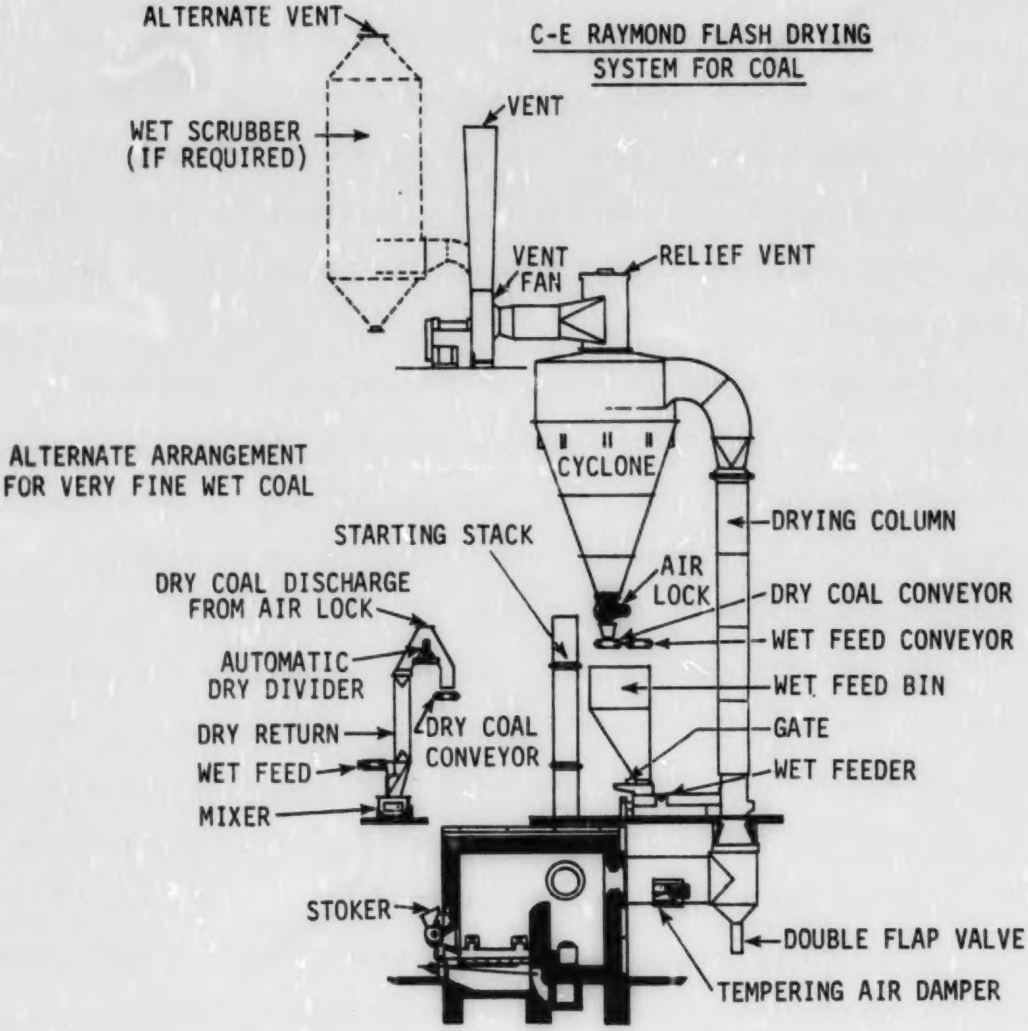


Figure 4-16. Flash dryer.

ally moves across the dryer, a little at each pass, from the feed point to the discharge point.

The cascade dryer is shown in Figure 4-15. The wet coal is fed to the dryer by a rotary feeder; as the shelves in the dryer vibrate, the coal cascades down through them and is collected in a conveyor at the bottom for evacuation. Hot gases are drawn upward through and between the wedge wire shelves.

The flash dryer is shown in Figure 4-16. The term "flash" is derived from the fact that the wet coal is continuously introduced into a column of high-temperature gases and moisture removal is practically instantaneous.

4.9 EMISSION SOURCES AND CONTROL DEVICES

All emission sources are subject to opacity regulations and two are subject to particulate count regulations. The pneumatic cleaning plants generate emissions from the air tables and are subject to one standard; thermal dryers have an emission stack and are subject to another standard.

Emission points in the various plant sections are shown in the appropriate diagrams. The most commonly used control devices for each emission point are keyed as follows:

(1) Cyclone

(2) Scrubber

(3) Spray

(4) Baghouse or fabric filter

(5) Enclosure

These parenthetical numbers are used in the following tabulation relating emission sources and their controls.

Coal Handling Facilities

RR and mine car dumps - 2,3,5
Truck dumps - 2,3,5
Storage bins and silos - 4,5
Breakers and crushers - 3,4,5
Conveyor transfer points - 3,4,5
Screens - 4,5
Trucks, RR car, and barge loading stations - 1,4,5

Pneumatic Cleaning Plant

Surge bin - 4,5
Thermal dryer stack (if present) - 1,2
Vibrating screens - 4,5
Air tables 1,4,5
Crusher - 3,4,5

Jig-Table Washing Plant

Screen - 4,5
Loading facility - 2,3,5
Thermal dryer (if present) - 1,2

Heavy-Media Washing Plant

Screen - 4,5
Loading facility - 2,3,5
Thermal dryer (if present) - 1,2

4.10 CONTROL DEVICES, THEIR CAPABILITIES AND EFFICIENCIES

The various control devices are employed singly or in combination at each emission point according to the temperatures and volumes of flue gases, the degree of contamination, and the applicable regulations.

Cyclone sizes range from 2 inches to 18 feet in diameter, the smaller being applied in groups that use a common inlet and dust hopper. A cyclone serves as a primary separator because its efficiency is limited to particles larger than 44 microns. The efficiency is a function of the particle mass, inlet velocity, and the radius of the cyclone, increasing with smaller radii and higher inlet velocities. Pressure drop also increases with velocity.

Some variables of cyclone design are indicated in Table 4-2.

Table 4-2. CYCLONE VARIABLES

	Cyc. dia.	Capacity, cfm	Inlet velocity, fps	Pressure drop, in.	Smallest size collected @50% eff., μ
Min.	2 in.	10	15	0.5	10
Max.	18 ft.	25,000	75	6.0	200

Cyclones are lined with refractories or water-jacketed for processing of hot gases and are fabricated of alloy steels for processing of corrosive gases.

Scrubbers are enclosures in which dust particles are agglomerated in small drops of water, which then flow from the vessel. In impingement-type scrubbers, agglomeration is accomplished by driving the dust-laden gas at high velocities onto flooded targets. Wet centrifugal separators pass the dust-laden air through a zone of high-velocity water droplets. Wet dynamic precipitators cause the dust to impinge on wetted fan blades. A venturi scrubber accelerates the dust-laden air through a venturi throat, where it atomizes the water to form droplets.

Scrubbers lose efficiency rapidly in collecting particles below 5 microns. Efficiency loss is proportional to the pressure drop or power consumption. The major scrubber variables are presented in Table 4-3.

Table 4-3. SCRUBBER VARIABLES

Scrubber type	Water consumption per 1,000 cfm gas, gpm	Pressure drop, in.	Capacity, cfm	Max. efficiency, % (Particle size range)
Impingement	3-5	6-8	90,000	95 (1-5 micron)
Centrifugal	4-10	2-6	140,000	90 (2-5 micron)
Dynamic	1	1	25,000[a]	95[a] (2-5 micron)
Venturi	3-15	12-60	140,000	98 (submicron)

[a] Estimated

Scrubbers are used for control of thermal dryer emissions because they can accommodate gas temperatures up to 250°F and are insensitive to the heavy moisture content. Orifice meters are commonly used for measuring the scrubber water flow rates.

Table 4-4 presents the flow rate variables for six common orifice sizes.

Table 4-4. ORIFICE FLOW RATES

Pressure lb/in^2	Water flow, gpm diameter of orifice, in.					
	3/16	1/4	5/16	3/8	7/16	1/2
20	3.0	5.2	8.1	11.7	15.8	20.1
30	3.6	6.4	10.0	14.4	19.5	25.4
40	4.1	7.4	11.5	16.5	22.4	29.4
50	4.6	8.2	12.8	18.5	25.0	32.9
60	5.1	9.0	14.0	20.2	27.5	36.0

Baghouses or fabric filters are applicable for capture of fine particles of dust when the gases are at moderate temperatures, contain no sticky materials, and are nonexplosive.

The dust-laden stream is passed through a finely woven or felted fabric on which a layer of dust serves as the filtering medium. As this dust layer thickens, the bag is "shaken" mechanically or by abrupt pressure changes to remove a portion of the filter cake.

The filter is usually in the shape of a circular closed-end cylinder 5 to 12 inches in diameter and up to 30 feet long. Smaller filters are used to control emissions from bin and silo openings. The size of a filter installation depends on the amount of air and dust to be filtered.

The ratio of air to filter cloth area depends on several variables; different services require different ratios or filtering velocities. The guidelines used for filtering of coal dusts are ratios of 6/1 for high dust loadings and elevated temperatures, progressing up to 8/1 for general dust loadings. Pressure differentials range from 2 to 10 inches w.g.

Fabrics are selected on a basis of chemical resistance, tensile strength, temperature resistance, weave, and electrostatic characteristics. Operating temperatures of some common fabrics are shown in Table 4-5.

Table 4-5. OPERATING TEMPERATURES

	Maximum operating temperature, °F	
	Long term	Short term
Cotton	160	200
Wool	200	250
Dacron	275	300
Glass	500	650
Nylon	200	250
Orlon	240	290

The mechanisms for cleaning the bags include hand shaking, reverse air jets, mechanical rappers, and bag shakers. Since a bag is out of service while it is being cleaned, the installation must be designed to accommodate this loss of service. The bags are fastened at the top, with quick-release fastenings to permit easy bag replacement, and are suspended in the dusty environment. A vacuum is introduced in the bag, pulling the air through the fabric bag for release through the top, leaving the dust collected on the exterior of the bags. In some installations the dusty air flows through the interior of the bag.

The baghouse containing the fabric filters may be square, rectangular, or circular and is constructed of metal. The vertical dimension exceeds the length of the bags, and the top or roof is flat. The open bottom is connected to a conical or pyramidal section, which receives the dust shaken from the bags for removal by an airlock feeder valve. The baghouse is self supporting, with suitable walkways for access.

5.0 INSTRUMENTATION AND RECORDS

Instrumentation for measurement of process parameters and methods of recording these measurements are important in controlling and predicting process emissions. The accuracy of predicting emissions can be directly related to the degree of sophistication of the instrumentation and record-keeping at the plant. The instrument reading provides an instantaneous indication of operating conditions; detailed records will provide a basis for reviewing plant operations over an extended period.

The flow of coal through the preparation equipment is a constant function of the amount of coal input at the feeder conveyor. Overloading of the feeder conveyor will result in overloading of the equipment following it. Most of the equipment incorporates an indicator showing instantaneously the load being processed.

In older plants most equipment control is of the ON-OFF type. In case of overloading, a red light comes on and the equipment is automatically stopped. These ON-OFF lights do not indicate in advance a potential malfunction or overload and are not helpful for indication of emissions.

The newer and larger plants generally incorporate a central control room with automated instrumentation showing the instantanous loading and other major parameters such as pressure drop and temperature of the gases. The monitoring records of required process parameters are also maintained in this central control room.

When the instruments indicate abnormal operating conditions, the operator can take action to prevent possible major equipment malfunction or plant shutdown. The use of instrument readings for predicting plant emissions is discussed in Section 8.0.

5.1 PROCESS INSTRUMENTATION

Instrumentation in the coal preparation plant is relatively simple in comparison with instrumentation at other process industries. The instruments generally found on coal preparation equipment are described below:

Conveyor

The conveyors are driven by electric motors; the current drawn by the conveyor motors varies directly with the conveyor load. The ammeters located in the control room indicate the instantaneous current drawn by the conveyor motors. When excessive current is indicated, conveyor and equipment loading should be investigated.

Some conveyors are also equipped with load meters. These meters indicate the percent of rated load carried by the conveyor at a particular instant. Ammeters and load meters give basically similar indications.

Crushers

The crusher load is directly proportional to the feed rate and feed sizes. The crusher is driven by an electric motor. The ammeter for the motor is generally located in the central control room. Indication of excessive current should be investigated to determine the cause.

Screens

In addition to the load-current ammeters, the screens may be equipped with pressure gauges indicating the pressure of water to the sprays. The various correct combinations of load current and spray pressure should be established during performance tests for reference during periodic inspections. The increase in load current would mean increased screen loading; this should be matched by increased spray water, which will be indicated by the pressure gauge.

Air Tables

In general, the new air table installations will be equipped with instruments to indicate the load current, pressure drop across the air table, and pressure drop across the control equipment. The load current is indicated by the ammeter; pressure drops are indicated by the pressure gauges. These instruments can be located in a central control room. The correct combinations of these parameters should be established during performance tests for future reference.

An excessive pressure drop across the air table means a higher percentage of fine coal in the table feed. This will also result in an increased load on the control device. The pressure drop across the control device should be matched to meet the increased particulate loading.

Thermal Dryers

Thermal dryers are equipped with instruments to indicate the feed rate and exit gas temperature. The exit gas temperature is continuously recorded and monitored. In the case of thermal dryers with venturi scrubbers, scrubber water supply pressure and pressure loss in the venturi constriction are also continuously monitored. The monitoring aspects are discussed under records in Section 5.2.

The thermal dryer feed rate indicates the quantitative loading; however, this may not be useful for predicting the emissions. Emissions from the thermal dryer would depend on the moisture and fine-coal percentage of the feed.

5.2 RECORDS

The NSPS require the continuous monitoring of the flue gas temperature at the exit of the thermal dryer, pressure of the water supply to the venturi scrubber, and pressure loss in the venturi constriction. A record of these parameters will be available at the plant for inspection.

Other records, though not required under NSPS, showing the plant feed rates and equipment malfunction and shutdown should be inspected to determine the plant's emissions between inspections.

6.0 START-UP, SHUTDOWN, AND MALFUNCTIONS

Emissions that occur during normal plant start-ups and shutdowns are exempted by regulations. The following sections discuss the possible causes of extended emission upsets and precautionary measures for preventing them. The primary emission sources are the air table and the thermal dryer, and, in some cases of malfunction, their control devices. The secondary emission sources are more numerous, less susceptible to upset, and more easily corrected. These sources are screens, breakers, crushers, conveyor transfer points, storage bins, loading and unloading stations, and supporting equipment.

In this section, a brief discussion of emisssion during plant start-up and shutdown is followed by analysis of malfunctions that can occur in regular plant operation.

6.1 START-UP AND SHUTDOWN

A normal interruption during a shift, such as that caused by car changes, lack of coal, or mechanical failure of equipment, usually does not cause an emission upset because the plant is kept running. The heat of the thermal dryer is regulated, and the other emission sources will receive no coal to create dust. Upon resumption of coal flow, the first coal encounters normal conditions.

In start-up at the beginning of a shift or after a long breakdown, the period of adjustment is short, lasting only until the flow of coal through the plant is complete. In the starting sequence, each unit (or several) is brought on-line at a time interval. The normal procedure, on automatic starting, would energize all water pumps, air compressors, and related dust control equipment before coal is received. The thermal dryer should be up to temperature, and all sprays should be operational. At a well-designed plant, this sequence is interlocked, without recourse to bypass.

Some plants are built with selected interlocks; these arrangements permit utilization of only certain sections of the plant or operation around nonfunctional equipment. Manual controls to allow bypassing of interlocks are common. Improper use of bypass features is the most probable reason for an emission upset during start-up of a plant with interlocks.

The shutdown procedure for some plants is automatically executed in the reverse of start-up, with some variations. This permits the plant to "empty" itself; more commonly, the "stop" sequence is timed to a shorter period than is required for traverse of the process circuit. In either event, the dust control equipment should be timed to continue operation after the coal feed is stopped, for a period long enough to allow the equipment to run clean.

The coal preparation incorporates an emergency "stop" button which halts all equipment instantly. This procedure entails no particular ill effects, since everything (including the thermal dryer) stops operating. However, if the incoming coal is near the capacity of the circuits and a buildup of dust has occurred in critical spots, a short emission upset may occur on start-up.

6.2 CHANGES IN COAL FEED

Analysis of the incoming coal may change sufficiently to create plant emission upsets. This is most likely to occur at a central preparation plant that processes coal from several mines and different coal seams. The second most vulnerable plant is one that serves a large mine producing from both conventional and continuous mining sections, the conventional type producing finer coal. Variable feed also can prevail at a plant receiving coal from a stripping operation with auger production.

Blending the raw coal, either from multiple storage units or by proportioned acceptance, will reduce the impacts of variable feed. Multiple storage facilities, however, are rare and very expensive; proportional feed is difficult and less positive as a control. Use of a single raw coal storage silo can produce the same problem at intervals, as can changes in surface moisture content caused by different levels of spraying underground, wet mines, precipitation on open storage piles, and exposure during transport.

In the discussions that follow, it is important to remember that malfunctions occurring at many points in the coal preparation circuit may be attributable, at least in part, to changes in coal feed.

6.3 MALFUNCTION OF SUPPORT EQUIPMENT

Malfunctions of supporting equipment, usually mechanical failure, can cause frequent or sustained interruptions of plant operations. The most usual are listed below.

Breakdown of conveyor drives, crushers, chains, centrifuges, feeders, pumps, or screen cloths.

Blockage in bins or release of veil-chains or plates into the coal flow.

Failure of magnetic protective equipment, permitting introduction of large "tramp" iron into the feed.

Electrical accidents, inadequate power source, or inadequate lightning protection.

Poorly controlled spraying, producing variable moisture content (at dry cleaning plants).

Damage of ROM conveyor belt from tramp iron, misalignment, or oversized rock.

6.4 MALFUNCTIONS IN SOURCES OF FUGITIVE DUST

Malfunctions in dust-producing equipment are caused by overload, poor maintenance or design, electrical failure, accident, or improper operation.

Air Table

The air table is most adversely affected by a sharp change in size distribution of the incoming coal to include greater amounts of extreme fines. This shift permits overloading of the dust control equipment. Simple overloading of the air table, which produces a similar condition, is caused by malfunction of the proportioning feeder on the air table or by desire of the operator to increase production. Air seals on the table, if not properly maintained, will become serious sources of fugitive dust emissions.

Thermal Dryer

The thermal dryer, like the air table, is subject to particulate emission standards.

Overheating of a thermal dryer may be caused by failure of a regulating valve (gas or oil fired) or other control and usually will produce an "upset" plume. The "internals" of dryers involve mechanical (sometimes moving) parts, which are subject to wear and damage. The refractory lining also is subject to wear and damage and is subject to scheduled replacement.

The second section of a thermal dryer is a large-diameter cyclone, used to extract the particulate matter larger than 300 M from the gas stream. This cyclone has no internal working parts, but the refractory lining is subject to wear. Volume of air, temperature, and pressure drop are the chief criteria for satisfactory or normal cyclone operation. Other causes of emissions are mechanical failure of the discharge feeder and wearing of seals.

The last section of a thermal dryer is a scrubber, used to remove the fine portion of coal (300 M x 0) from the air stream. The scrubber may incorporate a bypass for emergency use, which may be partially open and permit particulate emission. The inspector should examine the bypass during each plant inspection and should also examine records of bypass use.

The venturi scrubber is the type most commonly used. Its efficiency is a function of the volume, pressure drop, and temperature of the contaminated air and the volume and pressure of the scrubbing medium (water). Deviation from established norms can be checked by reference to records of previous plant inspections.

The inspector should examine the seals at manholes and duct collars for tight fit and should check the device for removal of solids and spent scrubbing liquids to ensure that it is not blocked partially open. With a "variable venturi" type scrubber, the inspector must be provided with a record of the "normal" setting. Water is introduced internally through a nozzle or sprays, which, if blocked or inoperative could affect a zone of the venturi adversely.

The moisture separators and/or demisters of a scrubber installation may become blocked, or partially so, particularly if they include a screen. Particular attention should be given to "ball-bed", "packed tower," and "packed bed" types of scrubbers, which incorporate a supplemental internal feature that may become blocked or cause resistance to the flow of gas or liquid.

Screens

Fugitive dust emissions occur at the screens when fine coal is involved. The coal preparation plants generally use three types of screens: grizzly, shaker, and vibrating.

Grizzly screens are used on ROM coal preceding a crusher or loading a belt conveyor. They usually are served by sprays but are sometimes enclosed. The doors, plates, and seals of the enclosure are highly subject to damage by pieces of metal or rock. Wet incoming material may cause plugging of the branch air duct from the enclosure to the dust collector, which should be sized to carry dust-laden air, at the minimum pressure available, at a velocity of not less than 4500 fpm.

Shaker screens are used infrequently, rarely providing a separation less than 2 inches (usually much larger). A hooded enclosure may be found alongside the screen. Principal malfunctions involve plugging, short-circuiting, or improper sizing of the conveying ducts, damage to the hood, or improper placement of the hood.

A vibrating screen is the most common separating device. Many screens are flooded with water and constitute no dust source. The "dry" screens usually make a separation at 1/4-3/8-1/2 inch and create fugitive dust. Malfunctions involve loose seals, damaged enclosures, open access doors, and blocked or short-circuited air ducts.

Crushers

Crushers, an important source of fugitive dust, are protected by sprays or dust collectors. A sudden appearance of fugitive dust may be caused by blockage or short-circuiting of air ducts, broken enclosures or seals, or open access doors. If operation of the crusher is changed, an upset may occur. A hammermill will respond to higher speeds with finer product and/or greater capacity, creating a new situation for dust control. Introduction of a coal of soft consistency also can introduce new problems.

Breakers are subject to the same types of malfunctions described for crushers, caused by broken, loose, or misplaced enclosures, blocked or short-circuited air ducts, open access doors, and overloading. Similarly, change of perforated plates to reduce the sizing or introduction of coal from different seams can cause fugitive dust emissions.

Conveyor Transfer Points

Conveyor transfer points are sources of fugitive dust when dry coal containing the 3/8 x 0 inch increment is processed. If the material is larger than 3/8 inch or surface moisture content exceeds about 9 percent, dust emissions do not occur. The enclosure usually has an access door, which may be removed or left open, thus short-circuiting the "pickup" air. Rubber seals or curtains also may be removed or damaged. Airflow may be insufficient to gather the dust. The duct carrying the dust-laden air away may be blocked, broken, or poorly sized. A damper may be in the wrong position, or the chute leading from the conveyor pulley may be blocked, permitting spillage. The duct should carry the volume of air at a velocity of 4500 fpm. Proper conveying pressure may be unavailable because of malfunction or overloading of the collecting device at the duct terminal. Speeding or overloading of a conveyor may cause an emission upset at the terminal. Reference to earlier inspection reports will disclose any deviation from the normal flow of coal at a given point. Most of the malfunctions described above are readily handled by maintenance and replacement of damaged components.

Storage Facilities

Storage bins or silos include several possible fugitive dust sources. The feeder underneath a bin may be enclosed in a structure similar to that at a belt conveyor transfer point just described, and the same malfunctions may occur.

Most storage bins and silos are covered and are loaded by the conveyor. The conveyor discharge has been discussed, but a supplemental bin exhaust should be present to equalize pressure inside against the volume of incoming coal. This port is sometimes equipped with a bin vent filter, which can become plugged because of infrequent filter changes or exposure to water. The bin may also have ducts leading from these vents to a central dust collector. The bin should be exhausted at an air volume rate equal to twice the volume of incoming coal. Emissions may occur if this amount of air is not provided or if the lines from the bin are inadequate, as discussed with respect to conveyors.

A third possible emission source is present on a few silos, usually storing ROM, which have large openings through the walls near the top and around the circumference at spaced intervals. These openings may have doors, which are normally closed to contain the coal within the silo.

Coal is released upon operator demand or when the silos become nearly full, flowing through the holes to open storage around the silo. This operation can produce substantial fugitive dust emissions.

Loading and Unloading Stations

The points at which outgoing coal is loaded and incoming coal is received constitute significant sources of fugitive dust emissions because of the large volumes of coal that are handled, often without adequate controls. The chutes, hoods, bins, and miscellaneous full or partial enclosures involved in unloading and loading operations are subject to the same malfunctions described earlier with respect to similar equipment elsewhere in the plant: passages are blocked or plugged, access doors are removed or left ajar, seals are broken or faulty, metal components are dented, corroded, or otherwise deteriorated. Essentially simple structures or devices may be inoperable because of damage that is undetected or ignored. The task of the inspector is to note and record all actual or possible points of dust emission requiring the attention of plant operators. Certain points of the coal transfer operations, however, are worthy of special note.

Unloading from railroad cars may involve the use of retractable chutes, operated pneumatically, which often lose precision because of wear or erratic power supply. Conventional loading of railroad cars is sometimes protected by oil spraying, the effectiveness of which may be deteriorated by broken or plugged sprays and lines, damaged pumps or tanks, erratic pressure control valves, and insufficient oil supply. Barge loading is by chute, retractable to a degree but still permitting free fall of the coal into the barges. In stockpile loading by conveyor, coal is discharged from a conveyor high in the air and falls either through retractable chutes or loading stacks. Loading stacks are hollow, stationary columns, either of steel or concrete, reaching from the ground to the belt conveyor discharge. They have staggered partial openings at different elevations, extending the entire length, to offer some protection from the wind and to permit accumulation of the stockpile around the exterior. If the closures are blocked in an open position, adverse air currents may be generated.

In all of the loading operations, windbreaks are essential for control of air currents. These should be well placed with respect to prevailing winds, and must be well maintained for maximum effectiveness.

The dust emission problems involved at stations for unloading of the ROM coal naturally are similar to those at loading points.

Truck dump bins sometimes are partially enclosed. Sheeting may be absent from these enclosures, either deliberately or by accident. Many such bins have no dust control system. Any hooded dust control must allow for very high airflow because of the high rate at which the air in the bin is exhausted.

Stations for unloading of railroad cars are normally housed, and the fugitive dust is controlled by sprays. Those with dust-collecting hoods are subject to the malfunctions described earlier.

6.5 MALFUNCTION OF CONTROL DEVICES

Malfunctions of control devices principally involve scrubbers, cyclones, sprays, baghouses, and dust collection systems. Scrubbers have been discussed in connection with thermal dryers.

A cyclone should be installed to operate on predetermined volumes of particulate-bearing air at given temperature limits, with a minimum stipulated recovery of particles in the various size ranges. Recovery is determined by the shape of the cyclone and the volume flow through it. This is true of all cyclones, whether single or in clusters, large or small, hot or cold.

Detecting the cause of a malfunction will involve isolating the circumstance that has changed since normal operation was recorded.

Air volume can be measured at the outlet of the cyclone. It may be low if the fan is worn, belts are loose or broken, or intake area is no longer sufficient to pass adequate air at the pressure available. Blockage anywhere in the system is equally damaging.

Temperature can be measured at the cyclone inlet. If it deviates from the design limits, the volume of air at a given pressure will be incorrect. Temperature variations of these proportions would probably reflect the introduction of heated air.

Determining pressure drop "across the cyclone" requires pressure readings before and after the device. Common problems are a worn vacuum pump, loose belts, and an opening in the duct following the cyclone. If the pressure is constant at the fan, the pressure has increased downstream from the cyclone or an accident has occurred within the cyclone.

The shape of the cyclone can be changed by large dents, fallout of the refractory liner, mechanical failure of the feeder discharging solids at the bottom, and by blockage due to accumulation of fire clay or wet fine coal on the interior walls. In a wet-wall cyclone, the flow of liquid down the interior walls may be inadequate to reach the bottom, causing buildup on the interior. In cyclone clusters, partial blockage of any of the several small units can reduce the flow of air. As with many of the processing components, a change in analysis of incoming coal can cause difficulty.

Spray systems in a coal preparation plant can range from low-pressure "fish tails" or hollow-nozzle types to high-pressure (300 psi) impingement types. A wetting agent is occasionally used in the spray water. Appearance of excessive particulate probably may be traced to one of the following causes:

- Introduction of more than normal amounts of dust.
- Misalignment, damage, or plugging of spray heads or header.
- Damage of a control valve.
- Plugging of a line filter or incoming line.
- Wear or damage of pump or drive.
- Lack of water.
- Damage of sensor device or on-off switch.
- Accumulations of ice in lines or spray heads.

The criteria for successful operation of fabric filters are pressure drop across the baghouse, temperature of the incoming air, and the volume of air per surface area of filter fabric. Other possible causes of fugitive dust emissions include the usual factors involving wear, damage, looseness, plugging, or other impediments to effective operation of fans, blowers, ducting, hoppers, and similar components. In addition, the inspector may check for the following:

- New bags pass fine particulate until they become permeated and coated. If new fabric is used it may not be compatible with the air velocity, temperature, or pH count of the stream.
- Interior diaphragms may be punctured or loose.
- Cleaning cycles may remove too many bags from the circuit, leaving an inadequate number in operation. This is most likely to occur just before planned maintenance, when a number of bags are tied off.
- The collecting hopper below the bags may be filled with dust. Foreign materials (bags, hose, tools) sometimes enter the hopper and cause blockage.
- Bag cleaning may be neglected in manual operation, or the rapping or shaking mechanisms may suffer mechanical failure; reverse air jet (pneumatic) systems or timing devices may fail or become plugged.
- Bypassing devices may become damaged, partially or completely blocked, or out of cycle.

Systems for collection of dust from various sources throughout the plant are made up of hoods and enclosures at emission points, with ducts leading to junctures and finally to a major duct to the collecting device, usually a baghouse. Each of the branch lines or ducts must be properly sized to maintain adequate flow. Air intakes or cleanouts located at critical points are equipped with dampers (valves), which can cause malfunction. Connection of branch lines to larger ones must not be sharp (45°, preferably 30°) and should enter from the top or sides, never opposing. Any bend in the ducting should have an inside radius of 2 times the pipe diameter. Introduction of water into the duct collection system is another source of potential trouble.

7.0 EMISSION PERFORMANCE TESTS

The emission performance tests are intended to serve as a basis for determining compliance status of the plant during later inspections. These initial performance tests, therefore, must be conducted under conditions that are representative of plant operation. Two factors are of paramount importance: the coal being cleaned and the equipment loadings during the test. Analysis of the coal processed in the test should be typical with respect to percentage of fines and moisture content. Similarly, equipment loadings, which usually will differ from the rated or design capacities, should represent the maximum continuous loading in plant operation. As discussed in the balance of this section, the inspector will work with plant officials and the emissions testing contractor in selection of process paramaters for the emissions test.

7.1 PRETEST PROCEDURES

Before details of the test procedure are established, the EPA inspector should discuss the test objectives with the persons involved. In providing background information for plant personnel, he will enhance their understanding of test procedures and thus establish a framework in which cooperative effort is likely. These pretest discussions will focus on three principal areas: the NSPS, the operating parameters, and the test schedule.

NSPS Briefing

The inspector should be prepared to explain the background of the New Source Performance Standards and their relationship to the overall EPA goals. He should give details of the procedures used by EPA in setting the standards and explain the units in which emissions are reported, as required by regulations. He will point out that the NSPS specifically require monitoring of thermal dryer temperature, water supply pressure to the venturi scrubber, and pressure loss in the venturi constriction. Although details of plant operation are highly variable, the inspector will find that detailed knowledge of coal cleaning processes and of EPA activities will enable him to answer questions effectively.

Operating Parameters

The effects of all the major process variables will determine selection of process parameters during the emission performance tests. The selected values should represent the higher extreme of emission levels encountered in plant operations. As mentioned earlier, the major process variables affecting emissions are coal analysis (fines and moisture) and feed rate.

The percentage of fines in the feed entering a thermal dryer or air table will directly and proportionally affect the potential emissions through the equipment. Greater percentages of fine coal in the feed may result in larger amounts of particulate matter escaping through the control device to the atmosphere. For control of emissions to the level specified by the regulations, a higher pressure drop would be required across the scrubber. Therefore, the percentage of fines in the feed during a performance test should represent the higher extremes encountered in continuous plant operation.

Moisture content of feed coal has a similar direct effect. Notice also, however, that higher moisture content of the feed will result in reduction of air table emissions and fugitive dust emissions. A higher moisture content of feed entering the thermal dryer may result in flue gases with higher moisture, causing potential difficulty in assessing compliance with opacity standards.

The feed load (tonnage) during the performance test should be representative of the maximun continuous rate at which the plant is operated in overload conditions. This will ensure representative high loading of the process equipment during the test.

Test Schedule

The emission performance test schedule will be determined jointly by the inspector, the test contractor, and plant personnel. Plant personnel should provide information regarding the schedule and analysis of coal receipts, scheduled maintenance, operating schedules and similar operating factors. The inspector will discuss fully with plant personnel and the test contractor the methods and procedures of testing. Size of test crew will depend on the number of sampling points and total test duration. An experienced emission testing contractor will be able to make that judgment, with concurrence of the inspector and plant officials.

Local weather conditions and forecasts should be considered as the testing time approaches. Significant rainfall or snowfall could limit the effectiveness and accuracy of emissions tests.

It is of utmost importance that the inspector take proper safety measures to prevent mishaps during the plant inspections. He should always use personal protective equipment such as hard hat, safety glasses or goggles, ear plugs, safety belts, and safety shoes during the plant visit. Where the plant prescribes standard safety procedures for protection of staff and visiting personnel, he should adhere to these strictly during the inspections.

Table 7.1 outlines major planning responsibilities of the three groups involved in emission performance tests.

7.2 TEST MONITORING

It is important to remember that the initial emissions tests determine the reliability of later emission compliance inspections and tests. All persons involved in the emissions tests should seek to ensure that the tests are conducted fairly and the test results are valid.

The inspector plays a major role in monitoring the test procedures and plant operating parameters during the test period. He must ensure that the tests are carried out according to standard procedures.

The following are key factors to be monitored continuously during the tests:

- Plant feed rate.
- Percentage of fines and moisture content of the feed.
- Air table feed rate and baghouse pressure.
- Thermal dryer feed rate and exit gas temperature.
- Durations and intervals of emissions tests.

Table 7-2 presents a detailed inspection checklist to aid the inspector in performing his duties in a thorough and objective manner.

At least three sets of process observations are recommended. The number of stack test observations during

Table 7-1. EMISSION PERFORMANCE TEST RESPONSIBILITIES

Group/Person	Responsibilities
EPA Inspector	◦ Arrange pretest meeting; explain test goals and procedures.
	◦ Review and approve test schedule prepared by test contractor.
	◦ Check location of test points.
	◦ Select test feed analysis and feed rate in consultation with plant personnel and request that major parameters be recorded.
	◦ Observe and follow normal safety procedures and those specified at the plant.
Plant Personnel	◦ Provide information for inspector regarding types of coals cleaned and maximum feed rates.
	◦ Provide work area for test contractor.
	◦ Identify emission points.
	◦ Identify and prepare ports.
	◦ Provide details of stack sites and control equipment.
	◦ Provide details of plant instrumentation.
	◦ Provide equipment maintenance schedule; select test dates in consultation with inspector and test contractor.
	◦ Present test schedule to equipment operators and supervisors.
Test Contractor	◦ Familiarize test crew with test sites, methods, and NSPS requirements.
	◦ Prepare test schedule; obtain approval from inspector and plant personnel.

Table 7-2. CHECKLIST FOR PERFORMANCE TEST

GENERAL INFORMATION

Plant Name:______________________________

Mine Name:______________________________

Plant Address:______________________________

____

Contact at Plant:______________________________

Date of Inspection:______________________________

Inspected by:______________________________

____

Plant Rated Feed Capacity, ton/hr:____________ ____________

Plant Feed Rate, ton/hr:______________________________

Year of Plant Commissioning/
Major Modification:______________________________

Facility Data: Cleaning Techniques
☐ Wet
☐ Dry
☐ Other________________

Number of Stacks:______________________________

(continued)

Table 7-2 (continued).

COAL DATA

COAL SEAM: 1 ______________________________

2 ______________________________

3 ______________________________

	Raw coal as received			Refuse coal		
	1	2	3	1	2	3
Size						
Surface moisture, %						
1/4 x 0, %						
Ash, %						
Strip mining, %						
Continuous mining, %						
Conventional mining, %						

(continued)

Table 7-2 (continued).

EQUIPMENT CHECKLIST

WEIGHING DEVICE:

☐ Available ☐ Not Available

Type: ______________________

Scale design capacity: ______________________

Size of coal weighed: ☐ ROM ☐ 1/4 x 0

☐ Other ______________

Last date of calibration: ______________________

Prescribed calibration frequency: ______________________

Plant hourly feed rate during inspection, ton/hr

1st hour	2nd hour	3rd hour	4th hour	5th hour	6th hour

Average hourly feed rate, ton/hr: ______________

Maximum hourly feed rate, ton/hr: ______________

PRIMARY CRUSHER/CRUSHER ENCLOSURE:

Feed rate: ______________________ ton/hr

Feed capacity: ______________________ ton/hr

Load current: ______________________ amperes

Fugitive dust control: ☐ Good ☐ Poor

Type: ☐ Spray ☐ Cyclone ☐ Fab. Filter

Opacity of Emission:[a] ________ %

---

[a] Use EPA Method 9 for all opacity readings.

(continued)

Table 7-2 (continued).

SECONDARY CRUSHER

Feed rate:_________________________ ton/hr

Feed capacity:______________________ton/hr

Load current:______________________amperes

Fugitive dust control: ☐ Good ☐ Poor

Type: ☐ Spray ☐ Cyclone ☐ Fab. Filter

Opacity of Emission:__________%

AIR TABLE

Table No.	1	2	3	4
Baghouse No.				
Baghouse ΔP, in.				
Load current, amperes				
Cyclone No.				
Cyclone ΔP, in.				
Stack gas opacity, %				
Gas flow rate, acfm				
Particulate loading, gr/dscf				
Opacity, %				
Feed rate, t/hr				

(continued)

Table 7-2 (continued).

SCREENS/ENCLOSURES

	Screen No.			
	1	2	3	4
Location				
Feed rate, ton/hr				
Moisture content, %				
Product sizes				
Fugitive dust controls:				
Type: Spray Cyclone Fab. Filter				
Opacity of emission, %				

THERMAL DRYER

Type_____ __________________________Btu Rating _____________

Dryer feed rate:______________________ton/hr

Dryer feed size:______________________ton/hr

Feed moisture content:______________%

Product moisture content:___________%

Fan load current:____________________amperes

Fan suction ΔP:______________________in, vac.

Drying chamber ΔP:____________________in, vac.

Flue gas temperature at dryer exit: normal____°F
(for last 12 hrs. of continuous maximum_____°F
normal operation) minimum_____°F

Last date of temperature recorder
calibration:____

Cyclone outlet temperature:________°F

Cyclone ΔP:__________________________in.

(continued)

Table 7-2 (continued).

FLUE GAS SCRUBBER

Type:

° Water supply pressure (for last 12 hrs. of continuous normal operation)	Normal________in. Maximum________in. Minimum________in.
° Pressure loss at scrubber (for last 12 hrs. of continuous normal operation)	Normal________in. Maximum________in. Minimum________in.

Last date of recorder calibration:____________________

Prescribed frequency of calibration:____________________

° Opacity of flue gas at stack exit, % ____________________

Particulate concentration at exit, gr/dscf:____________________

CONVEYOR/TRANSFER POINTS

Draw a rough sketch of facility layout indicating and numbering the conveyors, using the graph paper on following page. Use same numbers to identify the conveyors in the following table:

	Conveyor No.			
	1	2	3	4
Location				
Receiving unit				
Discharge conveyor width, in.				
Discharge conveyor speed, ft/min.				
Rated capacity, ton/hr				
Load current, amperes				
Type of dust control: spray cyclone fab. filter				
Water press, in.				
Water flow, gpm				
Opacity of emission, %				

(continued)

Table 7-2 (continued).

FACILITY LAYOUT

(continue

Table 7-2 (continued).

LOADING STATION

Type: ☐ Truck ☐ Railroad ☐ Barge

☐ Unit Train ☐ Other ____________

Feed capacity: ______________________ ton/hr

Actual feed rate: ______________________ ton/hr

Extent of dust control: ☐ Good ☐ Poor

Fan load Current: __________ amperes

Type of dust control:

☐ Spray: Water supply pressure _____ in., flow ____ gpm

☐ Cyclone: Pressure drop __________ in., flow ___ cfm

☐ Fabric filter: Pressure drop _____ in., flow ___ cfm

Condition of collector bags __________

Emission opacity _____ %

UNLOADING STATION

Type: ☐ Truck ☐ Barge ☐ Railroad

Feed capacity: ______________ ton/hr

Actual feed rate: ______________ ton/hr

Type of Control device:

☐ Spray: Pressure drop ___________ in., flow ___ gpm

☐ Cyclone: Pressure drop __________ in., flow ___ cfm

☐ Fabric filter: Pressure drop _____ in., flow ____ cfm

Condition of collector bags

Emission opacity ______ %

(continued)

7-2 (continued).

COAL STORAGE

Type: ☐ Silo ☐ Fabricated Bin

Location: ____

Size of coal stored: ________________________________

Type of coal stored: _____ Raw coal _____ Washed coal

Dust control device:

☐ Spray

Water supply pressure _______ in., flow ____ gpm

☐ Cyclone

Pressure drop _______________ in., flow ____ cfm

☐ Fabric filter

Pressure drop _______________ in., flow ____ cfm

Fan load current ____________ amps.

Condition of collector bags ___________________

Storage design feed rate ________ __ton/hr

Actual feed rate __________________ ton/hr

(continued)

Table 7-2 (continued).

FIELD OBSERVATION CHECKLIST

GENERAL/ADMINISTRATIVE

PLANT NAME ______________________________ DATE ______________

PLANT ADDRESS ____

SOURCE TO BE TESTED ____

PLANT CONTACT ____________________________ PHONE _____________

OBSERVERS ____________________ AFFILIATION __________________

______________________________ ______________________________

______________________________ ______________________________

REVIEWED TEST PROTOCOL? __________ COMMENTS ___________________

REVIEWED PRETEST MEETING NOTES? ______ COMMENTS ________________

____

REVIEWED CORRESPONDENCE? ________ COMMENTS _____________________

____

TEST TEAM COMPANY NAME ______________________ PHONE ___________

SUPERVISOR'S NAME ________________ ADDRESS _____________________

OTHER MEMBERS ____________________ TITLE _______________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

(continued)

Table 7-2 (continued).

GENERAL/SAMPLING SITE

STACK/DUCT CROSS-SECTION DIMENSIONS_________ EQUIVALENT DIAMETER_______________

MATERIAL OF CONSTRUCTION_____________ CORRODED?_____ LEAKS? _________________

INTERNAL APPEARANCE: CORRODED?_______ CAKED PARTICULATE?_____ THICKNESS ______

INSULATION?____ THICKNESS______ LINING?_______ THICKNESS ______________________

NIPPLE?_____ I.D._______ LENGTH_____ FLUSH WITH INSIDE WALL? _________________

STRAIGHT RUN BEFORE PORTS________ DIAMETERS _________________________________

STRAIGHT RUN AFTER PORTS_________ DIAMETERS _________________________________

PHOTOS TAKEN?_________ OF WHAT____

DRAWING OF SAMPLING LOCATION:

MINIMUM INFORMATION ON DRAWING: STACK/DUCT DIMENSIONS, LOCATION AND DESCRIPTION OF MAJOR DISTURBANCES AND ALL MINOR DISTURBANCES, TRANSMISSOMETERS, AND CROSS-SECTIONAL VIEW SHOWING DIMENSIONS AND PORT LOCATIONS.

(continued)

Table 7-2 (continued).

GENERAL/SAMPLING SYSTEM

SAMPLING METHOD (e.g., EPA 5)____________________________________

SAMPLING TRAIN SCHEMATIC DRAWING:

MODIFICATIONS TO STANDARD METHOD_________________________________

PUMP TYPE: FIBERVANE WITH IN-LINE OILER_____ CARBON VANE _____ DIAPHRAGM _______

PROBE LINER MATERIAL______________ HEATED?_______ ENTIRE LENGTH?_______________

TYPE "S" PITOT TUBE?______ OTHER______________________________________

PITOT TUBE CONNECTED TO: INCLINED MANOMETER___ OR MAGNEHELIC GAUGE ____________

RANGE_________ APPROX. SCALE LENGTH_________ DIVISIONS ___________________

METER BOX BRAND______________ SAMPLE BOX BRAND___________________________________

RECENT CALIBRATION OF ORIFICE METER-DRY METER?_____ PITOT TUBES?_______________

NOZZLES?____ THERMOMETERS OR THERMOCOUPLES?___ MAGNEHELIC GAUGES?___________

NUMBER OF SAMPLING POINTS/TRAVERSE FROM FED. REG.___ NUMBER TO BE USED _________

LENGTH OF SAMPLING TIME/POINT DESIRED_____ TIME TO BE USED______________________

(continued)

Table 7-2 (continued).

SAMPLING (USE ONE SHEET FOR EACH RUN IF NECESSARY)   RUN #______________

PROBE-SAMPLE BOX MOVEMENT TECHNIQUE:________________________________

IS NOZZLE SEALED WHEN PROBE IS IN STACK WITH PUMP TURNED OFF?______________

IS CARE TAKEN TO AVOID SCRAPING NIPPLE ON STACK WALL?__________________

IS AN EFFECTIVE SEAL MADE AROUND PROBE AT PORT OPENING?_________________

IS PROBE SEAL MADE WITHOUT DISTURBING FLOW INSIDE STACK?________________

IS PROBE MOVED TO EACH POINT AT THE PROPER TIME?______________________

IS PROBE MARKING SYSTEM ADEQUATE TO PROPERLY LOCATE EACH POINT?___________

ARE NOZZLE AND PITOT TUBE KEPT PARALLEL TO STACK WALL AT EACH POINT?_________

IF PROBE IS DISCONNECTED FROM FILTER HOLDER WITH PROBE IN THE STACK ON A NEGATIVE PRESSURE SOURCE, HOW IS PARTICULATE MATTER IN THE PROBE PREVENTED FROM BEING SUCKED BACK INTO THE STACK?________________

IF FILTERS ARE CHANGED DURING A RUN, WAS ANY PARTICULATE LOST?____________

METERBOX OPERATION:

ARE DATA RECORDED IN A PERMANENT MANNER?______ ARE DATA SHEETS COMPLETE?______

AVERAGE TIME TO REACH ISOKINETIC RATE AT EACH POINT____________________

IS NOMOGRAPH SETTING CHANGED WHEN STACK TEMPERATURE CHANGES SIGNIFICANTLY?____

ARE VELOCITY PRESSURES (Δp) READ AND RECORDED ACCURATELY?________________

IS LEAK TEST PERFORMED AT COMPLETION OF RUN?____ cfm @____IN Hg.

PROBE, FILTER HOLDER, IMPINGERS SEALED ADEQUATELY AFTER TEST?_____________

GENERAL COMMENT ON SAMPLING TECHNIQUES

IF ORSAT ANALYSIS IS DONE, WAS IT: FROM STACK?____FROM INTEGRATED BAG?________

WAS BAG SYSTEM LEAK TESTED? WAS ORSAT LEAK TESTED?____CHECKED AGAINST AIR?______

IF DATA SHEETS CANNOT BE COPIED, RECORD: APPROXIMATE STACK TEMPERATURE ________°F

NOZZLE DIA._____IN.   VOLUME METERED _____ACF

LIST ALL Δp READINGS____

____

(continued)

Table 7-2 (continued).

TRAIN ASSEMBLY/FINAL PREPARATIONS (USE ONE SHEET PER RUN IF NECESSARY) RUN #_____

FILTER HOLDER CLEAN BEFORE TEST?_____FILTER HOLDER ASSEMBLED CORRECTLY?_____________

FILTER MEDIA TYPE ________FILTER CLEARLY IDENTIFIED?_____FILTER INTACT?_____________

PROBE LINER CLEAN BEFORE TEST?_____NOZZLE CLEAN?_____NOZZLE UNDAMAGED?_____________

IMPINGERS CLEAN BEFORE TEST?_____ IMPINGERS CHARGED CORRECTLY?_____________________

BALL JOINTS OR SCREW JOINTS?_____ GREASE USED?______ KIND OF GREASE ______________

PITOT TUBE TIP UNDAMAGED?______ PITOT LINES CHECKED FOR LEAKS?___PLUGGING?__________

METER BOX LEVELED?_____PITOT MANOMETER ZEROED?_____ORIFICE MANOMETER ZEROED?_________

PROBE MARKINGS CORRECT?_____PROBE HOT ALONG ENTIRE LENGTH?_______________________

FILTER COMPARTMENT HOT?______TEMPERATURE INFORMATION AVAILABLE?___________________

IMPINGERS ICED DOWN?_____THERMOMETER READING PROPERLY?____________________________

BAROMETRIC PRESSURE MEASURED?______IF NOT, WHAT IS SOURCE OF DATA?_______________

$\Delta H_@$ FROM MOST RECENT CALIBRATION______$\Delta H_@$ FROM CHECK AGAINST DRY GAS METER_________

NOMOGRAPH CHECK:

IF $\Delta H_@ = 1.80$, TM = 100° F, % H_2O = 10%, $P_s/P_m = 1.00$, C =_____(0.95)

IF C = 0.95, TS = 200° F, DN = 0.375, Δp REFERENCE =______(0.118)

ALIGN $\Delta p = 1.0$ WITH $\Delta H = 10$; @ $\Delta p = 0.01$, ΔH =______(0.1)

FOR NOMOGRAPH SET-UP:

ESTIMATED METER TEMPERATURE______°F ESTIMATED VALUE OF P_s/P_m____________________

ESTIMATED MOISTURE CONTENT______% HOW ESTIMATED?_________________________________

C FACTOR_____ESTIMATED STACK TEMPERATURE_____°F DESIRED NOZZLE DIAMETER_________

STACK THERMOMETER CHECKED AGAINST AMBIENT TEMPERATURE?_____________________________

LEAK TEST PERFORMED BEFORE START IF SAMPLING?_____RATE_____CFM @____IN. Hg.

(continued)

Table 7-2 (continued).

SAMPLE RECOVERY

GENERAL ENVIRONMENT-CLEANUP AREA ________________________________

WASH BOTTLES CLEAN?________ BRUSHES CLEAN?________ BRUSHES RUSTY?__________

JARS CLEAN?________ ACETONE GRADE______ RESIDUE ON EVAP. SPEC.____%

FILTER HANDLED OK?_______ PROBE HANDLED OK?_____ IMPINGERS HANDLED OK?_______

AFTER CLEANUP: FILTER HOLDER CLEAN?______ PROBE LINER CLEAN?______________

NOZZLE CLEAN?______ IMPINGERS CLEAN?______ BLANKS TAKEN?________________

DESCRIPTION OF COLLECTED PARTICULATE

SILICA GEL ALL PINK? RUN 1______ RUN 2____ RUN 3 _______

JARS ADEQUATELY LABELED?_______ JARS SEALED TIGHTLY?____________________

LIQUID LEVEL MARKED ON JARS?______ JARS LOCKED UP? ____________________

GENERAL COMMENTS ON ENTIRE SAMPLING PROJECT:

(continued)

Table 7-2 (continued).

SAMPLE TRANSPORT PARTICULATE CHECK LIST

- Samples are to be the direct responsibility of a senior member of the source test team until the responsibility is transferred to the laboratory supervisor.
- All liquid samples must be airtight, the liquid level marked, then stored properly upright to prevent spillage or breakage.
- All solid samples are to be sealed and stored to prevent the loss of samples or contamination from the ambient sources.
- All sample containers must be properly marked on outside to avoid rough handling during transport of the sample to the laboratory.
- All sample containers locked to insure the sample integrity during transport.
- The sample log (chain of custody) is initiated during sample recovery to insure quality assurance from the moment of collection.

(continued)

Table 7-2 (continued).

ANALYTICAL PARTICULATE CHECK LIST

- Analytical balance should be calibrated with Class S weights at the time of use.
- Desiccator contains anhydrous calcium sulfate.
- Filter and any loose particles from the sample container desiccated from 24 to 96 hours to a "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between consecutive weighings, with no less than 6 hours of desiccation time between weighings and no more than 2 minutes exposure to the laboratory atmosphere (must be less than 50% relative humidity) during weighing.
- Record level of liquid in containers on analytical data sheet to determine if leakage occurred during transport.
- Blank filters desiccated to a constant weight. Blank weight should not vary from original weight by more than ± 1.0 mg.
- Liquid in sample containers remeasured by the analyst either volumetrically to ± 1 ml or gravimetrically to ± 0.5 g.
- Acetone-rinse samples evaporate to dryness at ambient temperature and pressure in a tared 250-ml beaker. Prevent dust or objects from entering the beaker by placing a watch glass over the beaker during evaporation.
- The dried sample was desiccated to a constant weight and reported to the nearest 0.1 mg.
- The acetone blank was analyzed simultaneously with the acetone rinse using the same procedures.

(continued)

Table 7-2 (continued).

- Silica gel was weighed to the nearest 0.5 g using a balance in the field or laboratory.
- Sample beakers covered with parafilm and stored along with used filters until report is accepted by control agency or until such time as specified by the agency.

WAS THE TEST TEAM SUPERVISOR GIVEN THE OPPORTUNITY TO READ OVER THIS CHECKLIST?

DID HE DO SO?____

OBSERVER'S NAME____________________________TITLE__________________

AFFILIATION_______________________________SIGNATURE_______________ emission performance tests will depend on the mutual agreement of the inspector, plant operators, and test contractor; for each set of stack test data, corresponding process data should be recorded. A separate copy of the checklist for each set of observations will facilitate the comparison of observations.

Note that NSPS regulations specify particulate concentrations only for thermal dryers and air tables; all other equipment is governed by opacity regulations. The values observed during the test should fall within the limits prescribed by the regulations. If they do not, plant officials should be notified so that they may take the necessary corrective action. The inspector should then schedule another test in accordance with agency policy.

8.0 PERIODIC COMPLIANCE INSPECTIONS

Periodic inspections following the emissions performance tests will enable the inspector to determine the current compliance status of the plant. The inspection mainly involves comparison of current plant operations with those recorded during the emissions tests. The plant instrumentation and records constitute the major information source for the inspector. In addition, he will use the emissions test checklist for periodic inspection, presented as Table 8-1.

8.1 PERFORMING THE PERIODIC INSPECTION

The periodic inspection generally involves the following steps:

- Obtain schedule of plant operations during the proposed inspection period.
- Study all available plant data including details of the performance tests, emission points, and control equipment.
- Study instrumentation data gathered in performance tests.
- Note unusual characteristics of the plant, and comments made by previous inspectors.
- Inform plant officials of the proposed inspection and ensure that records are current and available for inspection.

Table 8-1. CHECKLIST FOR PERIODIC INSPECTION

GENERAL INFORMATION

Plant Name:____________________

Mine Name:____________________

Plant Address:____________________

____

Contact at Plant:____________________

Date of Inspection:____________________

Inspected by:____________________

____

Plant Rated Feed Capacity, ton/hr:____________________

Plant Feed Rate, ton/hr:____________________

Year of Plant Commissioning/
Major Modification:____________________

Facility Data: Cleaning Techniques
☐ Wet
☐ Dry
☐ Other__________

Number of Stacks:____________________

(continued)

Table 8-1 (continued).

COAL DATA

COAL SEAM: 1 ____________________

2 ____________________

3 ____________________

	Raw coal as received			Refuse coal		
	1	2	3	1	2	3
Size						
Surface moisture, %						
1/4 x 0, %						
Ash, %						
Strip mining, %						
Continuous mining, %						
Conventional mining, %						

(continued)

Table 8-1 (continued).
EQUIPMENT CHECKLIST

WEIGHING DEVICE:

☐ Available ☐ Not Available

Type: ____________________

Scale design capacity: ____________________

Size of coal weighed: ☐ ROM ☐ 1/4 x 0

☐ Other ____________________

Last date of calibration: ____________________

Prescribed calibration frequency: ____________________

Plant hourly feed rate during inspection, ton/hr

1st hour	2nd hour	3rd hour	4th hour	5th hour	6th hour

Average hourly feed rate, ton/hr: ____________________

Maximum hourly feed rate, ton/hr: ____________________

PRIMARY CRUSHER/CRUSHER ENCLOSURE:

Feed rate: ____________________ ton/hr

Feed capacity: ____________________ ton/hr

Load current: ____________________ amperes

Fugitive dust control: ☐ Good ☐ Poor

Type: ☐ Spray ☐ Cyclone ☐ Fab. Filter

Opacity of Emission:[a] ________%

---

[a] Use EPA Method 9 for all opacity readings.

(continued)

Table 8-1 (continued).

SECONDARY CRUSHER

Feed rate:_________________________ton/hr

Feed capacity:______________________ton/hr

Load current:_______________________amperes

Fugitive dust control: ☐ Good ☐ Poor

Type: ☐ Spray ☐ Cyclone ☐ Fab. Filter

Opacity of Emission:__________%

AIR TABLE

Table No.	1	2	3	4
Baghouse No.				
Baghouse ΔP, in.				
Load current, amperes				
Cyclone No.				
Cyclone ΔP, in.				
Stack gas opacity, %				
Gas flow rate, acfm				
Particulate loading, gr/dscf				
Opacity, %				
Feed rate, t/hr				

(continued)

Table 8-1 (continued).

SCREENS/ENCLOSURES

	Screen No.			
	1	2	3	4
Location				
Feed rate, ton/hr				
Moisture content, %				
Product sizes				
Fugitive dust controls:				
Type: Spray Cyclone Fab. Filter				
Opacity of emission, %				

THERMAL DRYER

Type ________________________________ Btu Rating ____________

Dryer feed rate: ____________________ ton/hr

Dryer feed size: ____________________ ton/hr

Feed moisture content: ______________ %

Product moisture content: ___________ %

Fan load current: ___________________ amperes

Fan suction ΔP: _____________________ in, vac.

Drying chamber ΔP: __________________ in, vac.

Flue gas temperature at dryer exit: normal ____°F
(for last 12 hrs. of continuous maximum _____°F
normal operation) minimum _____°F

Last date of temperature recorder
calibration: ____

Cyclone outlet temperature: ________°F

Cyclone ΔP: _________________________ in.

(continued)

Table 8-1 (continued).

FLUE GAS SCRUBBER

Type:

° Water supply pressure (for last 12 hrs. of continuous normal operation)	Normal________in. Maximum________in. Minimum________in.
° Pressure loss at scrubber (for last 12 hrs. of continuous normal operation)	Normal________in. Maximum________in. Minimum________in.

Last date of recorder calibration:________________

Prescribed frequency of calibration:________________

° Opacity of flue gas at stack exit, % ________________

Particulate concentration at exit, gr/dscf:________________

CONVEYOR/TRANSFER POINTS

Draw a rough sketch of facility layout indicating and numbering the conveyors, using the graph paper on following page. Use same numbers to identify the conveyors in the following table:

	Conveyor No.			
	1	2	3	4
Location				
Receiving unit				
Discharge conveyor width, in.				
Discharge conveyor speed, ft/min.				
Rated capacity, ton/hr				
Load current, amperes				
Type of dust control: spray cyclone fab. filter				
Water press, in.				
Water flow, gpm				
Opacity of emission, %				

(continued)

Table 8-1 (continued).

(continued)

Table 8-1 (continued).

LOADING STATION

Type: ☐ Truck ☐ Railroad ☐ Barge
☐ Unit Train ☐ Other ________________

Feed capacity: ______________________________ ton/hr

Actual feed rate: ____________________________ ton/hr

Extent of dust control: ☐ Good ☐ Poor

Fan load Current: __________ amperes

Type of dust control:

☐ Spray: Water supply pressure _____ in., flow ____ gpm

☐ Cyclone: Pressure drop __________ in., flow ____ cfm

☐ Fabric filter: Pressure drop _____ in., flow ____ cfm

Condition of collector bags ____________

Emission opacity _____ %

UNLOADING STATION

Type: ☐ Truck ☐ Barge ☐ Railroad

Feed capacity: __________________ ton/hr

Actual feed rate: ________________ ton/hr

Type of Control device:

☐ Spray: Pressure drop ____________ in., flow ____ gpm

☐ Cyclone: Pressure drop __________ in., flow ____ cfm

☐ Fabric filter: Pressure drop _____ in., flow ____ cfm

Condition of collector bags

Emission opacity ______ %

(continued)

Table 8-1 (continued).

COAL STORAGE

Type: ☐ Silo ☐ Fabricated Bin

Location: ____

Size of coal stored: ______________________________

Type of coal stored: _____ Raw coal _____ Washed coal

Dust control device:

☐ Spray

Water supply pressure _______ in., flow ____ gpm

☐ Cyclone

Pressure drop ______________ in., flow ____ cfm

☐ Fabric filter

Pressure drop ______________ in., flow ____ cfm

Fan load current ____________ amps.

Condition of collector bags ___________________

Storage design feed rate __________ ton/hr

Actual feed rate _________________ ton/hr

(continued)

Table 8-1 (continued).

ADDITIONAL CHECKS DURING PERIODIC INSPECTION

RECORDS

	Satisfactory	Unsatisfactory
Weigh feeders	☐	☐
Scrubber water supply	☐	☐
Pressure loss at scrubber	☐	☐
Dryer exit gas temperature	☐	☐

COMMENTS ON OPERATION OF PLANT EQUIPMENT BETWEEN THE INSPECTIONS

The frequency of inspections is governed by agency policy. A quarterly inspection is recommended unless complaints dictate more frequent inspections.

Duration of the inspection will depend on the plant layout and number of emission sources; usually, however, each plant inspection requires 6 to 8 hours. Three sets of observations are recommended for each inspection.

Major emphasis of the inspection is on checking facility records and observing the operation of process and control equipment, including instrumentation. The following procedures should be performed in the order shown whenever possible. The suggested format enables the inspector to tour the plant, observe the process, and monitor the instruments during operation.

Observations Outside the Plant

- Note plume opacity.
- Check whether weighing devices are properly operating.

Observations Inside the Plant

- Use periodic inspection checklist (Table 8-1) for recording process parameters and control equipment data.
- Plant records of thermal dryer exit temperature, water supply to the scrubber, and pressure loss in the scrubber provide information on operations during the period between inspections. The inspector should be satisfied that the records are accurate and should not hesitate to ask for further information.

8.2 DETERMINING COMPLIANCE STATUS

Compliance status of the plant is determined chiefly by comparing the inspection observations with those obtained during performance tests and previous inspections. Although such comparisons do not allow the prediction of quantitative emission rates, they do serve to indicate any emission upsets. Understanding the significance of each item in the checklist allows the inspector to weigh the effects of each item on process emissions. The relationships of checklist items with process emissions are discussed below.

Coal Data

The coal moisture content and percentage of fine coal (-1/4 in.) determine the loadings of the thermal dryer and air tables. Higher percentages of fine coal in the feed tend to increase thermal dryer emissions. Higher moisture content also increases the thermal dryer loading. If the feed analysis differs significantly from those recorded earlier, further investigation should be made.

Feed Rate

In general, the feed rates during periodic inspections should not be higher than those observed during performance tests. An increase in feed rate increases the loading of processing equipment. Normal feed variations up to 10 percent may not significantly affect the emissions. An increase in feed rates should be compensated for by additional controls, such as higher flow rates for sprays and higher pressure drop across the venturi. Any increase in feed rates higher than 10 percent should be questioned.

Load Current

The preparation equipment generally includes ammeters that indicate the load current. Load current values should be compared with those observed during performance tests. Overloading of equipment will be indicated by the increase in demand of load current.

Fugitive Dust Opacity

NSPS regulations specify the opacity limits for fugitive dust emissions. Opacity readings according to Method 9 should be taken to determine the fugitive dust emission compliance.

Compliance Action

If values observed in a periodic compliance test indicate that a citation is warranted, the inspector must clearly state to plant officials the grounds for such a citation. An on-site citation is justified only by clear-cut violations, such as excessive opacity or failure of the plant to maintain or provide required records.

REFERENCES

1. Leonard, J.W., and D.R. Mitchell (eds.). Coal Preparation. Third Edition. New York. Society of Mining Engineers of AIME. 1968.

2. Background Information for Standards of Performance: Coal Preparation Plants, Volume 1: Proposed Standards. U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA-450/2-74-021a. October 1974.

3. Casey, J. Compilation of Technical Information on the Coal Preparation Industry. U.S. Environmental Protection Agency. Research Triangle Park, N.C. (unpublished).

4. Background Information for Standards of Performance: Coal Preparation Plants, Volume 2: Test Data Summary. U.S. Environmental Protection Agency. Research Triangle Park, N.C. EPA-450/2-74-0216. October 1974.

5. Air Pollutant Emission Factors Supplement (TRW Systems Group) for U.S. Environmental Protection Agency. Research Triangle Park, N.C. Contract No. CPA 22-69-119. August 1970.

6. Compilation of Air Pollution Emission Factors. Second Edition. U.S. Environmental Protection Agency. Research Triangle Park, N.C. AP-42. April 1973.

7. Soderberg, H.E. Environmental, Energy, and Economic Considerations in Particulate Control. Mining Congress Journal 24-29, December 1974.

8. Technical Guide for Review and Evaluation of Compliance Schedules for Air Pollution Sources. PEDCo-Environmental Specialists, Inc. for U.S. Environmental Protection Agency. Research Triangle Park, N.C. EPA Contract No. 68-02-0607. July 1973.

APPENDIX A

NEW SOURCE PERFORMANCE STANDARDS

COAL PREPARATION PLANTS

[FRL 462-7]

PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Coal Preparation Plants

On October 24, 1974 (39 FR 37922), under section 111 of the Clean Air Act, as amended, the Environmental Protection Agency (EPA) proposed standards of performance for new and modified coal preparation plants. Interested parties were afforded an opportunity to participate in the rulemaking by submitting written comments. Twenty-seven comment letters were received; six from coal companies, four from Federal agencies, four from steel companies, four from electric utility companies, three from State and local agencies, three from coal industry associations and three from other interested parties.

Copies of the comment letters and a supplemental volume of background information which contains a summary of the comments with EPA's responses are available for public inspection and copying at the U.S. Environmental Protection Agency, Public Information Reference Unit, Room 2922, 401 M Street, S.W., Washington, D.C. 20460. In addition, the supplemental volume of background information which contains copies of the comment summary with EPA's responses may be obtained upon written request from the EPA Public Information Center (PM-215), 401 M Street S.W., Washington, D.C. 20460 (specify Background Information for Standards of Performance: Coal Preparation Plants, Volume 3: Supplemental Information). The comments have been carefully considered, and where determined by the Administrator to be appropriate, changes have been made to the proposed regulations and are incorporated in the regulations promulgated herein.

The bases for the proposed standards are presented in "Background Information for Standards of Performance: Coal Preparation Plants" (EPA 450/2-74-021a, b). Copies of this document are available on request from the Emission Standards Protection Agency, Research Triangle and Engineering Division, Environmental Park, North Carolina 27711, Attention: Mr. Don R. Goodwin.

Summary of Regulation. The promulgated standards of performance regulate particulate matter emissions from coal preparation and handling facilities processing more than 200 tons/day of bituminous coal (regardless of their location) as follows: (1) emissions from thermal dryers may not exceed 0.070 g/dscm (0.031 gr/dscf) and 20% opacity, (2) emissions from pneumatic coal cleaning equipment may not exceed 0.040 g/dscm (0.018 gr/ dscf) and 10% opacity, and (3) emissions from coal handling and storage equipment (processing nonbituminous as well as bituminous coal) may not exceed 20% opactity.

Significant Comments and Revisions to the Proposed Regulations. Many of the comment letters received by EPA contained multiple comments. These are summarized as follows with discussions of any significant differences between the proposed and promulgated regulations.

1. *Applicability*.—Comments were received noting that the proposed standards would apply to any coal handling operation regardless of size and would require even small tipple operations and domestic coal distributors to comply with the proposed standards for fugitive emissions. In addition, underground mining activities may have been inadvertently included under the proposed standards. EPA did not intend to regulate either these small sources or underground mining activities. Only sources which break, crush, screen, clean, or dry large amounts of coal were intended to be covered. Sources which handle large amounts of coal would include coal handling operations at sources such as barge loading facilities, power plants, coke ovens, etc. as well as plants that primarily clean and/or dry coal. EPA concluded that sources not intended to be covered by the regulation handle less than 200 tons/day; therefore, the regulation promulgated herein exempts such sources.

Comments were received questioning the application of the standards to facilities processing nonbituminous coals (including lignite). As was stated in the preamble to the proposed regulation, it is intended for the standards to have broad applicability when appropriate. At the time the regulation was proposed, EPA considered the parameters relating to the control of emissions from thermal dryers to be sufficiently similar, whether bituminous or nonbituminous coal was being dried. Since the time of proposal, EPA has reconsidered the application of standards to the thermal drying of nonbituminous coal. It has concluded that such application is not prudent in the absence of specific data demonstrating the similarity of the drying characteristics and emission control characteristics to those of bituminous coal. There are currently very few thermal dryers or pneumatic air cleaners processing nonbituminous fuels. The facilities tested by EPA to demonstrate control equipment representative of best control technology were processing bituminous coal. Since the majority of the EPA test data and other information used to develop the standards are based upon bituminous coal processing, the particulate matter standards for thermal dryers and pneumatic coal cleaning equipment have been revised to apply only to those facilities processing bituminous coal.

The opacity standard for control of fugitive emissions is applicable to nonbituminous as well as bituminous coal since nonbituminous processing facilities will utilize similar equipment for transporting, screening, storing, and loading coal, and the control techniques applicable for minimizing fugitive particulate matter emissions will be the same regardless of the type of coal processed. Typically enclosures with some type of low energy collectors are utilized. The opacity of emissions can also be reduced by effectively covering or sealing the process from the atmosphere so that any avenues for escaping emissions are small. By minimizing the number and the dimensions of the openings through which fugitive emissions can escape, the opacity and the total mass rate of emissions can be reduced independently of the air pollution control devices. Also, water sprays have been demonstrated to be very effective for suppressing fugitive emissions and can be used to control even the most difficult fugitive emission problems. Therefore, the control of fugitive emissions at all facilities will be required since there are several control techniques that can be applied regardless of the type of coal processed.

2. *Thermal dryer standard.*—One commentator presented data and calculations which indicated that because of the large amount of fine particles in the coal his company processes, compliance with the proposed standard would require the application of a venturi scrubber with a pressure drop of 50 to 52 inches of water gage. The proposed standard was based on the application of a venturi scrubber with a pressure drop of 25 to 35 inches. EPA thoroughly evaluated this comment and concluded that the commentator's calculations and extrapolations could have represented the actual situation. Rather than revise the standard on the basis of the commentator's estimates, EPA decided to perform emission tests at a plant which processes the coal under question. The plant tested is controlled with a venturi scrubber and was operated at a pressure drop of 29 inches during the emission tests. These tests showed emissions of 0.080 to 0.134 g/dscm (0.035 to 0.058 gr/dscf). These results are numerically greater than the proposed standard; however, calculations indicate that if the pressure drop were increased from 29 inches to 41 inches, the proposed standard would be achieved. Supplemental information regarding estimates of emission control needed to achieve the mass standard is contained in Section II, Volume 3 of the supplemental background information document.

Since the cost analysis of the proposed standard was based on a venturi scrubber operating at 25 to 35 inches venturi pressure loss, the costs of operating at higher pressure losses were evaluated. These results indicated that the added cost of controlling pollutants to the level of the proposed standard is only 14 cents per ton of plant product even if a 50 inch pressure loss were used, and only five cents per ton in excess of the average control level required by state regulations in the major coal producing states. In comparison to the $18.95 per ton delivered price of U.S. coal in 1974 and even higher prices today, a maximum five cents per ton economic impact attributable to these regulations appears almost negligible. The total impact of 14 cents per ton for controlling particulate matter emissions can easily be passed along to the customer since the demand for thermal drying due to freight rate savings, the elimination of handling problems due to freezing, and the needs of the customer's process (coke ovens must control bulk density and power plants must control plugging of pulverizers) will remain unaffected by these regulations. Therefore, the economic impact of the standard upon thermal drying will not be large and the inflationary impact of the standard on the price of coal will be insignificant (one percent or less). From the standpoint of energy consumption, the power requirements of the air pollution control equipment are exponentially related to the control level such that a level of diminishing return is reached. Because the highest pressure loss that has been demonstrated by operation of a venturi scrubber on a coal dryer is 41 inches water gage, which is also the pressure loss estimated by a scrubber vendor to be needed to achieve the 70 mg/dscm standard, and because energy consumption increases dramatically at lower control levels (<70 mg/dscm), a particulate matter standard lower than 70 mg/dscm was not selected. At the 70 mg/dscm control level, the trade-off between control of emissions at the thermal dryer versus the increase in emissions at the power plant supplying the energy is favorable even though the mass quantity of all air pollutants emitted by the power plant (SO_2, NO_x, and particulate matter) are compared only to the reduction in thermal dryer particulate matter emissions. At lower than 70 mg/dscm, this trade-off is not as favorable due to the energy requirements of venturi scrubbers at higher pressure drops. For this source, alternative means of air pollution control have not been fully demonstrated. Having considered all comments on the particulate matter regulation proposed for thermal dryers, EPA finds no reason sufficient to alter the proposed standard of 70 mg/dscm except to restrict its applicability to thermal dryers processing bituminous coal.

3. *Location of thermal drying systems.*—Comments were received on the applicability of the standard for power plants with closed thermal drying systems where the air used to dry the coal is also used in the combustion process. As indicated in § 60.252(a), the standard is concerned only with effluents which are discharged into the atmosphere from the drying equipment. Since the pulverized coal transported by heated air is charged to the steam generator in a closed system, there is no discharge from the dryer directly to the atmosphere, therefore, these standards for thermal dryers are not applicable. Effluents from steam generators are regulated by standards previously promulgated (40 CFR Part 60 subpart D). However, these standards do apply to all bituminous coal drying operations that discharge effluent to the atmosphere regardless of their physical or geographical location. In additions to thermal dryers located in coal preparation plants, usually in the vicinity of the mines, dryers used to preheat coal at coke ovens are alsoregulated by these standards. These coke oven thermal dryers used for preheating are similar in all respects, including the air pollution control equipment, to those used in coal preparation plants.

4. *Opacity standards.*—The opacity standards for thermal dryer and pneumatic coal cleaners were reevaluated as a result of revisions to Method 9 for conducting opacity observations (39 FR 39872). The opacity stndards were proposed prior to the revisions of Method 9 and were not based upon the concept of averaging sets of 24 observations for six-minute periods. As a result, the proposed standards were developed in relation to the peak emissions of the facility rather than the average emissions of six-minute periods. The opacity data collected by EPA have been reevaluated in accordance with the revised Method 9 procedures, and opacity standards for thermal dryers and pneumatic coal cleaners have been adjusted to levels consistent with these new procedures. The opacity standards for thermal dryers and pneumatic coal cleaners have been adjusted from 30 and 20 percent to 20 and 10 percent opacity, respectively. Since the proposed standards were based upon peak rather than average opacity, the revised standards are numerically lower. Each of these levels is justified based primarily upon six-minute averages of EPA opacity observations. These data are contained in Section III, Volume 3 of the supplemental background information document.

5. *Fugitive emission monitoring.*—Several commentators identified some difficulties with the proposed procedures for monitoring the surface moisture of thermally dried coal. The purpose of the proposed requirement was to determine the probability of fugitive emissions occuring from coal handling operations

and to estimate their extent. The commentators noted that the proposed A.S.T.M. measurement methods are difficult and cumbersome procedures not typically used by operating facilities. Also, it was noted that there is too little uniformity of techniques within industry for measuring surface moisture to specify a general method. Secondly, estimation of fugitive emissions from such data may not be consistent due to different coal characteristics. Since the opacity standard promulgated herein can readily be utilized by enforcement personnel, the moisture monitoring requirement is relatively unimportant. EPA has therefore eliminated this requirement from the regulation.

6. *Open storage piles.*—The proposed regulation applied the fugitive emission standard to coal storage systems, which were defined as any facility used to store coal. It was EPA's intention that this definition refer to some type of structure such as a bin, silo, etc. Several commentators objected to the potential application of the fugitive emission standard to open storage piles. Since the fugitive emission standard was not developed for application to open storage piles, the regulations promulgated herein clarifies that open storage piles of coal are not regulated by these standards.

7. *Thermal dryer monitoring equipment.*—A number of commentators felt that important variables were not being considered for monitoring venturi scrubber operation on thermal dryers. The proposed standards required monitoring the temperature of the gas from the thermal dryer and monitoring the venturi scrubber pressure loss. The promulgated standard requires, in addition to the above parameters, monitoring of the water supply pressure to the venturi scrubber. Direct measurement of the water flow rate was considered but rejected due to potential plugging problems as a result of solids typically found in recycled scrubber water. Also, the higher cost of a flow rate meter in comparison to a simpler pressure monitoring device was a factor in the selection of a water pressure monitor for verifying that the scrubber receives adequate water for proper operation. This revision to the regulations will insure monitoring of major air pollution control device parameters subject to variation which could go undetected and unnoticed and could grossly affect proper operation of the control equipment. A pressure sensor, two transmitters, and a two pen chart recorder for monitoring scrubber venturi pressure drop and water supply pressure, which are commercially available, will cost approximately two to three thousand dollars installed for each thermal dryer. This cost is only one-tenth of one percent of the total investment cost of a 500-ton-per-hour thermal dryer. The regulations also require monitoring of the thermal dryer exit temperature, but no added cost will result because this measurement system is normally supplied with the thermal drying equipment and is used as a control point for the process control system.

Effective date.—In accordance with section 111 of the Act, as amended, these regulations prescribing standards of performance for coal preparation plants are effective on January 15, 1976, and apply to thermal dryers, pneumatic coal cleaners, coal processing and conveying equipment, coal storage systems, and coal transfer and loading systems, the construction or modification of which was commenced after October 24, 1974.

Dated: January 8, 1976.

Russell E. Train,
Administrator.

Part 60 of Chapter I of Title 40 of the Code of Federal Regulations is amended as follows:

1. The table of contents is amended by adding subpart Y as follows:

* * * * *

Subpart Y—Standards of Performance for Coal Preparation Plants

Sec.
60.250 Applicability and designation of affected facility.
60.251 Definitions.
60.252 Standards for particulate matter.
60.253 Monitoring of operations.
60.254 Test methods and procedures.

Authority: Secs. 111 and 114 of the Clean Air Act, as amended by sec. 4(a) of Pub. L. 91–604, 84 Stat. 1678 (42 U.S.C. 1857c–6, 1857 c–9).

2. Part 60 is amended by adding subpart Y as follows:

* * * * *

Subpart Y—Standards of Performance for Coal Preparation Plants

§ 60.250 Applicability and designation of affected facility.

The provisions of this subpart are applicable to any of the following affected facilities in coal preparation plants which process more than 200 tons per day: thermal dryers, pneumatic coal-cleaning equipment (air tables), coal processing and conveying equipment (including breakers and crushers), coal storage systems, and coal transfer and loading systems.

§ 60.251 Definitions.

As used in this subpart, all terms not defined herein have the meaning given them in the Act and in subpart A of this part.

(a) "Coal preparation plant" means any facility (excluding underground mining operations) which prepares coal by one or more of the following processes: breaking, crushing, screening, wet or dry cleaning, and thermal drying.

(b) "Bituminous coal" means solid fossil fuel classified as bituminous coal by A.S.T.M. Designation D–388–66.

(c) "Coal" means all solid fossil fuels classified as anthracite, bituminous, subbituminous, or lignite by A.S.T.M. Designation D–388–66.

(d) "Cyclonic flow" means a spiraling movement of exhaust gases within a duct or stack.

(e) "Thermal dryer" means any facility in which the moisture content of bituminous coal is reduced by contact with a heated gas stream which is exhausted to the atmosphere.

(f) "Pneumatic coal-cleaning equipment" means any facility which classifies bituminous coal by size or separates bituminous coal from refuse by application of air stream(s).

(g) "Coal processing and conveying equipment" means any machinery used to reduce the size of coal or to separate coal from refuse, and the equipment used to convey coal to or remove coal and refuse from the machinery. This includes, but is not limited to, breakers, crushers, screens, and conveyor belts.

(h) "Coal storage system" means any facility used to store coal except for open storage piles.

(i) "Transfer and loading system" means any facility used to transfer and load coal for shipment.

§ 60.252 Standards for particulate matter.

(a) On and after the date on which the performance test required to be conducted by § 60.8 is completed, an owner or operator subject to the provisions of this subpart shall not cause to be discharged into the atmosphere from any thermal dryer gases which:

(1) Contain particulate matter in excess of 0.070 g/dscm (0.031 gr/dscf).

(2) Exhibit 20 percent opacity or greater.

(b) On and after the date on which the performance test required to be conducted by § 60.8 is completed, an owner or operator subject to the provisions of this subpart shall not cause to be discharged into the atmosphere from any pneumatic coal cleaning equipment, gases which:

(1) Contain particulate matter in excess of 0.040 g/dscm (0.018 gr/dscf).

(2) Exhibit 10 percent opacity or greater.

(c) On and after the date on which the performance test required to be conducted by § 60.8 is completed, an owner or operator subject to the provisions of this subpart shall not cause to be discharged into the atmosphere from any coal processing and conveying equipment, coal storage system, or coal transfer and loading system processing coal, gases which exhibit 20 percent opacity or greater.

§ 60.253 Monitoring of operations.

(a) The owner or operator of any thermal dryer shall install, calibrate, maintain, and continuously operate monitoring devices as follows:

(1) A monitoring device for the measurement of the temperature of the gas stream at the exit of the thermal dryer on a continuous basis. The monitoring device is to be certified by the manufacturer to be accurate within ±3° Fahrenheit.

(2) For affected facilities that use venturi scrubber emission control equipment:

(i) A monitoring device for the continuous measurement of the pressure loss through the venturi constriction of the control equipment. The monitoring device is to be certified by the manufacturer to be accurate within ±1 inch water gage.

(ii) A monitoring device for the continuous measurement of the water supply pressure to the control equipment. The monitoring device is to be certified by the manufacturer to be accurate within ±5 percent of design water supply pressure. The pressure sensor or tap must be located close to the water discharge point. The Administrator may be consulted for approval of alternative locations.

(b) All monitoring devices under paragraph (a) of this section are to be recalibrated annually in accordance with procedures under § 60.13(b)(3) of this part.

§ 60.254 Test methods and procedures.

(a) The reference methods in Appendix A of this part, except as provided in § 60.8(b), are used to determine compliance with the standards prescribed in § 60.252 as follows:

(1) Method 5 for the concentration of particulate matter and associated moisture content,

(2) Method 1 for sample and velocity traverses,

(3) Method 2 for velocity and volumetric flow rate, and

(4) Method 3 for gas analysis.

(b) For Method 5, the sampling time for each run is at least 60 minutes and the minimum sample volume is 0.85 dscm (30 dscf) except that shorter sampling times or smaller volumes, when necessitated by process variables or other factors, may be approved by the Administrator. Sampling is not to be started until 30 minutes after start-up and is to be terminated before shutdown procedures commence. The owner or operator of the affected facility shall eliminate cyclonic flow during performance tests in a manner acceptable to the Administrator.

(c) The owner or operator shall construct the facility so that particulate emissions from thermal dryers or pneumatic coal cleaning equipment can be accurately determined by applicable test methods and procedures under paragraph (a) of this section.

[FR Doc.76-1240 Filed 1-14-76;8:45 am]

APPENDIX B

STANDARD TEST METHODS

Appendix A—Reference Methods[8]

METHOD 1—SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

1. *Principle and Applicability.*

1.1 Principle. A sampling site and the number of traverse points are selected to aid in the extraction of a representative sample.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. *Procedure.*

2.1 Selection of a sampling site and minimum number of traverse points.

2.1.1 Select a sampling site that is at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, contraction, or visible flame. For rectangular cross section, determine an equivalent diameter from the following equation:

$$\text{equivalent diameter}=2\left(\frac{(\text{length})(\text{width})}{\text{length}+\text{width}}\right) \qquad \text{equation 1-1}$$

2.1.2 When the above sampling site criteria can be met, the minimum number of traverse points is twelve (12).

2.1.3 Some sampling situations render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use Figure 1-1 to determine the minimum number of traverse points. Under no conditions should a sampling point be selected within 1 inch of the stack wall. To obtain the number of traverse points for stacks or ducts with a diameter less than 2 feet, multiply the number of points obtained from Figure 1-1 by 0.67.

2.1.4 To use Figure 1-1 first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Determine the corresponding number of traverse points for each distance from Figure 1-1. Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of 4, and for rectangular stacks the number follows the criteria of section 2.2.2.

2.2 Cross-sectional layout and location of traverse points.

2.2.1 For circular stacks locate the traverse points on at least two diameters according to Figure 1-2 and Table 1-1. The traverse axes shall divide the stack cross section into equal parts.

2.2.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to Figure 1-3.

3. *References.*

Determining Dust Concentration in a Gas Stream, ASME Performance Test Code #27, New York, N.Y., 1957.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif. November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif. Bulletin WP-50, 1968.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pa. 1971, ASTM Designation D-2928-71.

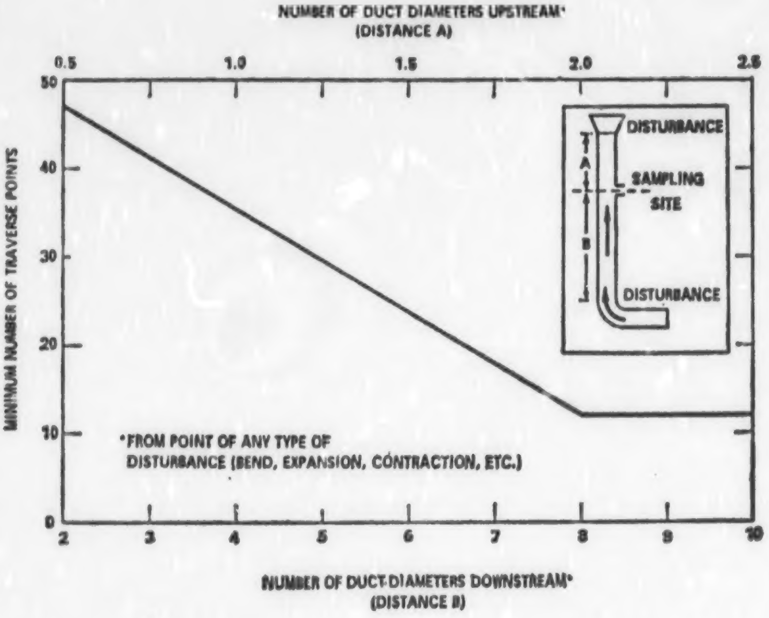


Figure 1-1. Minimum number of traverse points.

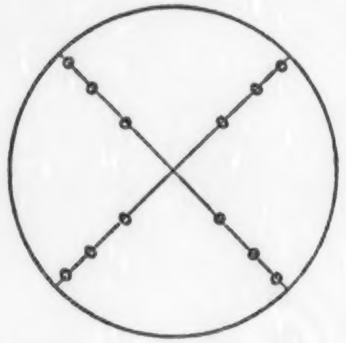


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

Table 1-1. Location of traverse points in circular stacks (Percent of stack diameter from inside wall to traverse point)[3]

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

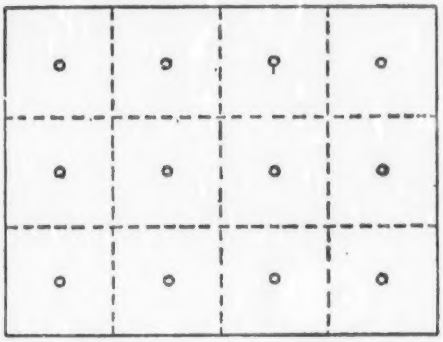


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

METHOD 2—DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

1. *Principle and applicability.*

1.1 Principle. Stack gas velocity is determined from the gas density and from measurement of the velocity head using a Type S (Stauscheibe or reverse type) pitot tube.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards.

2. *Apparatus.*

2.1 Pitot tube—Type S (Figure 2-1), or equivalent, with a coefficient within ±5% over the working range.

2.2 Differential pressure gauge—Inclined manometer, or equivalent, to measure velocity head to within 10% of the minimum value.

2.3 Temperature gauge—Thermocouple or equivalent attached to the pitot tube to measure stack temperature to within 1.5% of the minimum absolute stack temperature.

2.4 Pressure gauge—Mercury-filled U-tube manometer, or equivalent, to measure stack pressure to within 0.1 in. Hg.

2.5 Barometer—To measure atmospheric pressure to within 0.1 in. Hg.

2.6 Gas analyzer—To analyze gas composition for determining molecular weight.

2.7 Pitot tube—Standard type, to calibrate Type S pitot tube.

3. *Procedure.*

3.1 Set up the apparatus as shown in Figure 2-1. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by Method 1.

3.2 Measure the static pressure in the stack.

3.3 Determine the stack gas molecular weight by gas analysis and appropriate calculations as indicated in Method 3.

4. *Calibration.*

4.1 To calibrate the pitot tube, measure the velocity head at some point in a flowing gas stream with both a Type S pitot tube and a standard type pitot tube with known coefficient. Calibration should be done in the laboratory and the velocity of the flowing gas stream should be varied over the normal working range. It is recommended that the calibration be repeated after use at each field site.

4.2 Calculate the pitot tube coefficient using equation 2-1.

$$C_{p_{test}}=C_{p_{std}}\sqrt{\frac{\Delta p_{std}}{\Delta p_{test}}}\quad \text{equation 2-1}$$

where:

$C_{p_{test}}$ = Pitot tube coefficient of Type S pitot tube.

$C_{p_{std}}$ = Pitot tube coefficient of standard type pitot tube (if unknown, use 0.99).

Δp_{std} = Velocity head measured by standard type pitot tube.

Δp_{test} = Velocity head measured by Type S pitot tube.

4.3 Compare the coefficients of the Type S pitot tube determined first with one leg and then the other pointed downstream. Use the pitot tube only if the two coefficients differ by no more than 0.01.

5. *Calculations.*

Use equation 2-2 to calculate the stack gas velocity.

$$(V_s)_{avg.}=K_pC_p(\sqrt{\Delta p})_{avg.}\sqrt{\frac{(T_s)_{avg.}}{P_sM_s}}$$

Equation 2-2

where:

$(V_s)_{avg.}$ = Stack gas velocity, feet per second (f.p.s.).

$K_p=85.48\frac{\text{ft.}}{\text{sec.}}\left(\frac{\text{lb.}}{\text{lb. mole-°R}}\right)^{1/2}$ when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{avg.}$ = Average absolute stack gas temperature, °R.

$(\sqrt{\Delta p})_{avg.}$ = Average velocity head of stack gas, inches H_2O (see Fig. 2-2).

P_s = Absolute stack gas pressure, inches Hg.

M_s = Molecular weight of stack gas (wet basis), lb./lb.-mole.

$M_d(1-B_{wo})+18B_{wo}$

M_d = Dry molecular weight of stack gas (from Method 3).

B_{wo} = Proportion by volume of water vapor in the gas stream (from Method 4).

Figure 2-2 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of Figure 2-2 to determine the average stack gas velocity from Equation 2-2.

Use Equation 2-3 to calculate the stack gas volumetric flow rate.

$$Q_s=3600\ (1-B_{wo})V_sA\left(\frac{T_{std}}{(T_s)_{avg.}}\right)\left(\frac{P_s}{P_{std}}\right)$$

Equation 2-3

where:

Q_s = Volumetric flow rate, dry basis, standard conditions, ft.³/hr.

A = Cross-sectional area of stack, ft.²

T_{std} = Absolute temperature at standard conditions, 530° R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6. *References.*

Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements. Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14–19, 1970.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pa., 1971, ASTM Designation D-2928-71.

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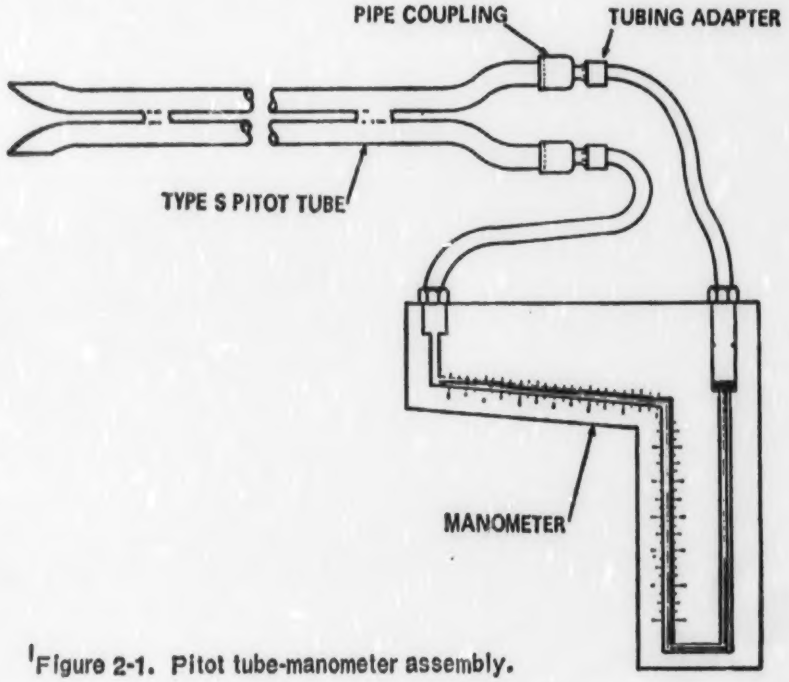

Figure 2-1. Pitot tube-manometer assembly.

PLANT______________________________

DATE______________________________

RUN NO.____________________________

STACK DIAMETER, in.____________________

BAROMETRIC PRESSURE, in. Hg_______________

STATIC PRESSURE IN STACK (P_g), in. Hg.________

OPERATORS__________________________

SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_S), °F
	AVERAGE:		

Figure 2-2. Velocity traverse data.

METHOD 3—GAS ANALYSIS FOR CARBON DIOXIDE, EXCESS AIR, AND DRY MOLECULAR WEIGHT

1. *Principle and applicability.*

1.1 Principle. An integrated or grab gas sample is extracted from a sampling point and analysed for its components using an Orsat analyser.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. The test procedure will indicate whether a grab sample or an integrated sample is to be used.

2. *Apparatus.*

2.1 Grab sample (Figure 3–1).

2.1.1 Probe—Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.1.2 Pump—One-way squeeze bulb, or equivalent, to transport gas sample to analyser.

2.2 *Integrated sample (Figure 3–2).*

2.2.1 Probe—Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.2.2 Air-cooled condenser or equivalent—To remove any excess moisture.

2.2.3 Needle valve—To adjust flow rate.

2.2.4 Pump—Leak-free, diaphragm type, or equivalent, to pull gas.

2.2.5 Rate meter—To measure a flow range from 0 to 0.035 cfm.

2.2.6 Flexible bag—Tedlar,[1] or equivalent, with a capacity of 2 to 3 cu. ft. Leak test the bag in the laboratory before using.

2.2.7 Pitot tube—Type S, or equivalent, attached to the probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

2.3 *Analysis.*

2.3.1 Orsat analyser, or equivalent.

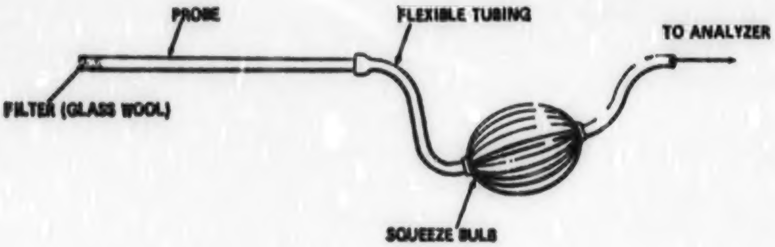

Figure 3-1. Grab-sampling train.

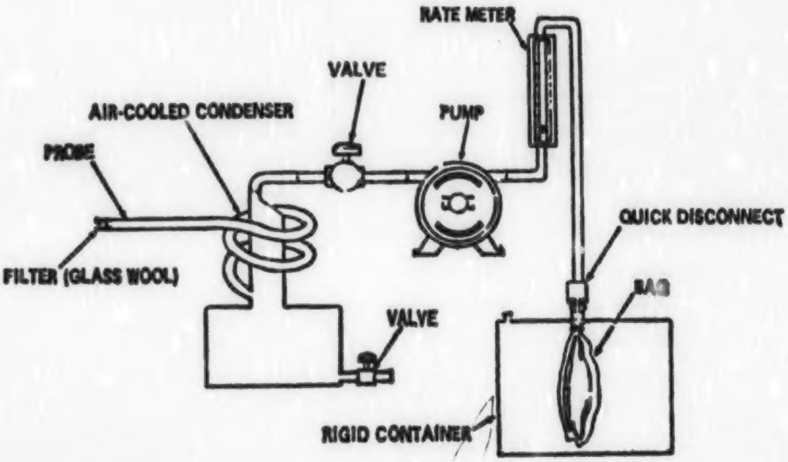

Figure 3-2. Integrated gas - sampling train.

3. *Procedure.*

3.1 Grab sampling.

3.1.1 Set up the equipment as shown in Figure 3–1, making sure all connections are leak-free. Place the probe in the stack at a sampling point and purge the sampling line.

3.1.2 Draw sample into the analyser.

3.2 Integrated sampling.

3.2.1 Evacuate the flexible bag. Set up the equipment as shown in Figure 3–2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are tight and that there are no leaks.

3.2.2 Sample at a rate proportional to the stack velocity.

3.3 Analysis.

3.3.1 Determine the CO_2, O_2, and CO concentrations as soon as possible. Make as many passes as are necessary to give constant readings. If more than ten passes are necessary, replace the absorbing solution.

3.3.2 For grab sampling, repeat the sampling and analysis until three consecutive samples vary no more than 0.5 percent by volume for each component being analyzed.

3.3.3 For integrated sampling, repeat the analysis of the sample until three consecutive analyses vary no more than 0.2 percent by volume for each component being analyzed.

4. *Calculations.*

4.1 Carbon dioxide. Average the three consecutive runs and report the result to the nearest 0.1% CO_2.

4.2 Excess air. Use Equation 3–1 to calculate excess air, and average the runs. Report the result to the nearest 0.1% excess air.

$$\%\,EA = \frac{(\%\,O_2) - 0.5(\%\,CO)}{0.264(\%\,N_2) - (\%\,O_2) + 0.5(\%\,CO)} \times 100$$

equation 3–1

where:

$\%EA$ = Percent excess air.
$\%O_2$ = Percent oxygen by volume, dry basis.
$\%N_2$ = Percent nitrogen by volume, dry basis.
$\%CO$ = Percent carbon monoxide by volume, dry basis.
0.264 = Ratio of oxygen to nitrogen in air by volume.

4.3 Dry molecular weight. Use Equation 3–2 to calculate dry molecular weight and average the runs. Report the result to the nearest tenth.

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO)$$

equation 3–2

where:

M_d = Dry molecular weight, lb./lb-mole.
$\%CO_2$ = Percent carbon dioxide by volume, dry basis.
$\%O_2$ = Percent oxygen by volume, dry basis.
$\%N_2$ = Percent nitrogen by volume, dry basis.
0.44 = Molecular weight of carbon dioxide divided by 100.
0.32 = Molecular weight of oxygen divided by 100.
0.28 = Molecular weight of nitrogen and CO divided by 100.

5. *References.*

Altshuller, A. P., et al., Storage of Gases and Vapors in Plastic Bags, Int. J. Air & Water Pollution, 6:75–81, 1963.

Conner, William D., and J. S. Nader, Air Sampling with Plastic Bags, Journal of the American Industrial Hygiene Association, 25:291–297, May–June 1964.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif., November 1963.

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[1] Trade name.

METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and applicability.*

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and its weight is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources only when specified by the test procedures for determining compliance with New Source Performance Standards.

2. *Apparatus.*

2.1 Sampling train. The design specifications of the particulate sampling train used by EPA (Figure 5–1) are described in APTD-0581. Commercial models of this train are available.

2.1.1 Nozzle—Stainless steel (316) with sharp, tapered leading edge.

2.1.2 Probe—Pyrex[1] glass with a heating system capable of maintaining a minimum gas temperature of 250° F. at the exit end during sampling to prevent condensation from occurring. When length limitations (greater than about 8 ft.) are encountered at temperatures less than 600° F., Incoloy 825[1], or equivalent, may be used. Probes for sampling gas streams at temperatures in excess of 600° F. must have been approved by the Administrator.

2.1.3 Pitot tube—Type S, or equivalent, attached to probe to monitor stack gas velocity.

2.1.4 Filter Holder—Pyrex[1] glass with heating system capable of maintaining minimum temperature of 225° F.

2.1.5 Impingers / Condenser—Four impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers are of the Greenburg-Smith design, modified by replacing the tip with a ½-inch ID glass tube extending to one-half inch from the bottom of the flask. The second impinger is of the Greenburg-Smith design with the standard tip. A condenser may be used in place of the impingers provided that the moisture content of the stack gas can still be determined.

2.1.6 Metering system—Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5° F., dry gas meter with 2% accuracy, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 Barometer—To measure atmospheric pressure to ±0.1 inches Hg.

2.2 Sample recovery.

2.2.1 Probe brush—At least as long as probe.

2.2.2 Glass wash bottles—Two.

2.2.3 Glass sample storage containers.

2.2.4 Graduated cylinder—250 ml.

2.3 Analysis.

2.3.1 Glass weighing dishes.

2.3.2 Desiccator.

2.3.3 Analytical balance—To measure to ±0.1 mg.

2.3.4 Trip balance—300 g. capacity, to measure to ±0.05 g.

3. *Reagents.*

3.1 Sampling.

3.1.1 Filters—Glass fiber, MSA 1106 BH[1], or equivalent, numbered for identification and preweighed.

3.1.2 Silica gel—Indicating type, 6-16 mesh, dried at 175° C. (350° F.) for 2 hours.

3.1.3 Water.

3.1.4 Crushed ice.

3.2 Sample recovery.

3.2.1 Acetone—Reagent grade.

3.3 Analysis.

3.3.1 Water.

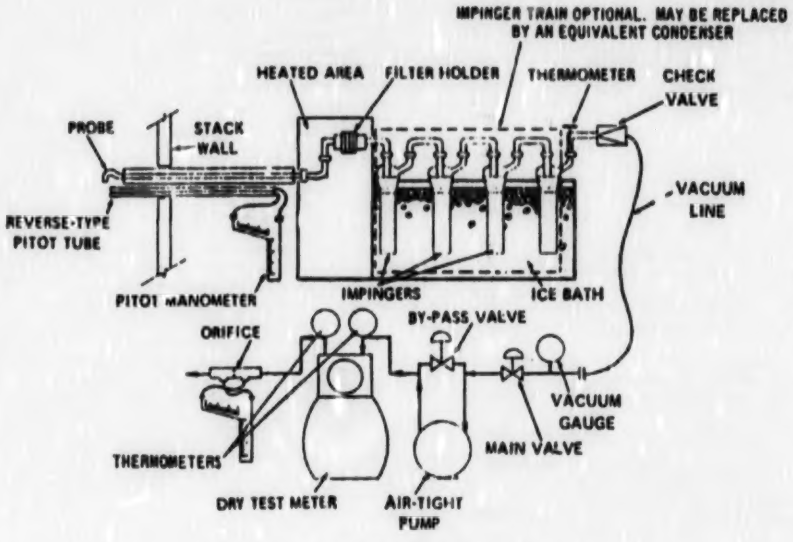

Figure 5-1. Particulate-sampling hain.

3.3.2 Desiccant—Drierite,[1] indicating.

4. *Procedure.*

4.1 Sampling

4.1.1 After selecting the sampling site and the minimum number of sampling points, determine the stack pressure, temperature, moisture, and range of velocity head.

4.1.2 Preparation of collection train. Weigh to the nearest gram approximately 200 g. of silica gel. Label a filter of proper diameter, desiccate[2] for at least 24 hours and weigh to the nearest 0.5 mg. in a room where the relative humidity is less than 50%. Place 100 ml. of water in each of the first two impingers, leave the third impinger empty, and place approximately 200 g. of preweighed silica gel in the fourth impinger. Set up the train without the probe as in Figure 5-1. Leak check the sampling train at the sampling site by plugging up the inlet to the filter holder and pulling a 15 in. Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15 in. Hg is acceptable. Attach the probe and adjust the heater to provide a gas temperature of about 250° F. at the probe outlet. Turn on the filter heating system. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger as low as possible and preferably at 70° F. or less. Temperatures above 70° F. may result in damage to the dry gas meter from either moisture condensation or excessive heat.

4.1.3 Particulate train operation. For each run, record the data required on the example sheet shown in Figure 5-2. Take readings at each sampling point, at least every 5 minutes, and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs are available which aid in the rapid adjustment of the sampling rate without other computations. APTD 0576 details the procedure for using these nomographs. Turn off the pump at the conclusion of each run and record the final readings. Remove the probe and nozzle from the stack and handle in accordance with the sample recovery process described in section 4.2.

4.2 Sample recovery. Exercise care in moving the collection train from the test site to the sample recovery area to minimize the loss of collected sample or the gain of extraneous particulate matter. Set aside a portion of the acetone used in the sample recovery as a blank for analysis. Measure the volume of water from the first three impingers, then discard. Place the samples in containers as follows:

Container No. 1. Remove the filter from its holder, place in this container, and seal.

Container No. 2. Place loose particulate matter and acetone washings from all sample-exposed surfaces prior to the filter in this container and seal. Use a razor blade, brush, or rubber policeman to lose adhering particles.

Container No. 3. Transfer the silica gel from the fourth impinger to the original container and seal. Use a rubber policeman as an aid in removing silica gel from the impinger.

4.3 Analysis. Record the data required on the example sheet shown in Figure 5–3. Handle each sample container as follows:

Container No. 1. Transfer the filter and any loose particulate matter from the sample container to a tared glass weighing dish, desiccate, and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 2. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 3. Weigh the spent silica gel and report to the nearest gram.

5. *Calibration.*

Use methods and equipment which have been approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater. Recalibrate after each test series.

6. *Calculations.*

6.1 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5–2).

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[1] Trade name.

[1] Trade name.

[2] Dry using Drierite[1] at 70° F. ±10° F.

6.2 Dry gas volume. Correct the sample volume measured by the dry gas meter to standard conditions (70° F., 29.92 inches Hg) by using Equation 5-1.

$$V_{m_{std}} = V_m\left(\frac{T_{std}}{T_m}\right)\left(\frac{P_{bar}+\frac{\Delta H}{13.6}}{P_{std}}\right) = \left(17.71\ \frac{°R}{\text{in. Hg}}\right)V_m\left(\frac{P_{bar}+\frac{\Delta H}{13.6}}{T_m}\right)$$

equation 5-1

where:

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

V_m = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

T_{std} = Absolute temperature at standard conditions, 530° R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inches Hg.

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of mercury.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.3 Volume of water vapor.

$$V_{w_{std}} = V_{l_c}\,\frac{\rho_{H_2O}}{M_{H_2O}}\,\frac{RT_{std}}{P_{std}}\,\frac{\text{lb.}}{\text{454 gm.}} = 0.0474\,\frac{\text{cu. ft.}}{\text{ml.}}\,V_{l_c}$$

equation 5-2[3]

where:

$V_{w_{std}}$ = Volume of water vapor in the gas sample (standard conditions), cu. ft.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

R = Ideal gas constant, 21.83 inches Hg—cu. ft./lb.-mole-°R.

T_{std} = Absolute temperature at standard conditions, 530° R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.4 Moisture content.

$$B_{wo} = \frac{V_{w_{std}}}{V_{m_{std}}+V_{w_{std}}}$$

equation 5-3

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$V_{w_{std}}$ = Volume of water in the gas sample (standard conditions), cu. ft.

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

6.5 Total particulate weight. Determine the total particulate catch from the sum of the weights on the analysis data sheet (Figure 5-3).

6.6 Concentration.

6.6.1 Concentration in gr./s.c.f.

$$c'_s = \left(0.0154\,\frac{\text{gr.}}{\text{mg.}}\right)\left(\frac{M_n}{V_{m_{std}}}\right)$$

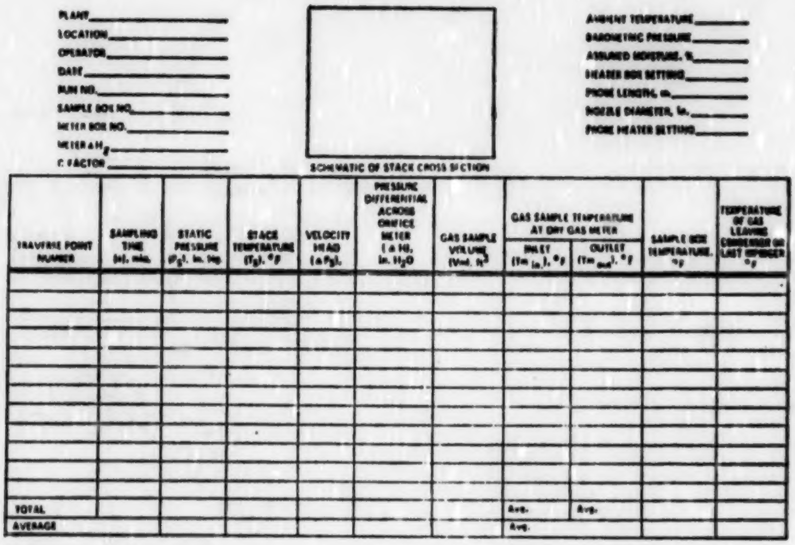
equation 5-4

where:

c'_s = Concentration of particulate matter in stack gas, gr./s.c.f., dry basis.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.



PLANT__________

LOCATION__________

OPERATOR__________

DATE__________

RUN NO.__________

SAMPLE BOX NO.__________

METER BOX NO.__________

METER $\Delta H_@$__________

C FACTOR__________

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE__________

BAROMETRIC PRESSURE__________

ASSUMED MOISTURE, %__________

HEATER BOX SETTING__________

PROBE LENGTH, m.__________

NOZZLE DIAMETER, in.__________

PROBE HEATER SETTING__________

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (P_s), in. Hg.	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s),	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH), in. H_2O	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE, °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °F
							INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F		
TOTAL							Avg.	Avg.		
AVERAGE							Avg.			

Figure 5-2. Particulate field data.

6.6.2 Concentration in lb./cu. ft.

$$c_s = \frac{\left(\frac{1}{453{,}600}\,\frac{\text{lb.}}{\text{mg.}}\right)M_n}{V_{m_{std}}} = 2.205\times10^{-6}\,\frac{M_n}{V_{m_{std}}}$$

equation 5-5

where:

c_s = Concentration of particulate matter in stack gas, lb./s.c.f., dry basis.

453,600 = Mg/lb.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.7 Isokinetic variation.

$$I = \frac{T_s\left[\left(\frac{0.00267\ \text{in. Hg-cu. ft.}}{\text{ml}-°R}\right)V_{l_c} + \frac{V_m}{T_m}\left(P_{bar}+\frac{H}{13.6}\right)\right]\left(1.667\,\frac{\text{min.}}{\text{sec.}}\right)}{\theta V_s P_s A_n}$$

equation 5-6[3]

where:

I = Percent of isokinetic sampling.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (See Fig. 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

R = Ideal gas constant, 21.83 inches Hg-cu. ft./lb.-mole-°R.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

V_m = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

T_m = Absolute average dry gas meter temperature (see Figure 5-2), °R.

P_{bar} = Barometric pressure at sampling site, inches Hg.

ΔH = Average pressure drop across the orifice (see Fig. 5-2), inches H_2O.

T_s = Absolute average stack gas temperature (see Fig. 5-2), °R.

θ = Total sampling time, min.

V_s = Stack gas velocity calculated by Method 2, Equation 2-2, ft./sec.

P_s = Absolute stack gas pressure, inches Hg.

A_n = Cross-sectional area of nozzle, sq. ft.

6.8 Acceptable results. The following range sets the limit on acceptable isokinetic sampling results:

If 90% ≤ I ≤ 110%, the results are acceptable, otherwise, reject the results and repeat the test.

7. *Reference.*

Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

Martin, Robert M., Construction Details of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0581.

Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0576.

Smith, W. S., R. T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63d Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

Smith, W. S., et al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67-119, 1967.

Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, 1967.

PLANT__________________

DATE ___________________

RUN NO._________________

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
TOTAL			

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		g* ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g/ml):

$$\frac{\text{INCREASE, g}}{(1\text{ g/ml})} = \text{VOLUME WATER, ml}$$

Figure 5-3. Analytical data.

METHOD 9—VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES 10

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error[1] of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. *Principle and applicability.*

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to § 60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. *Procedures.* The observer qualified in accordance with paragraph 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g. roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g. stub stacks on baghouses).

2.2 Field records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, and the date on a field data sheet (Figure 9–1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached steam plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached steam plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9–2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9–1 for an example.)

3. *Qualifications and testing.*

3.1 Certification requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Smoke generators used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke generator specifications. Any smoke generator used for the purposes of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9–1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9–1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

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[1] For a set, positive error=average opacity determined by observers' 25 observations—average opacity determined from transmissometer's 25 recordings.

TABLE 9-1—SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

Parameter:	*Specification*
a. Light source.....	Incandescent lamp operated at nominal rated voltage.
b. Spectral response of photocell.	Photopic (daylight spectral response of the human eye—reference 4.3).
c. Angle of view....	15° maximum total angle.
d. Angle of projection.	15° maximum total angle.
e. Calibration error.	±3% opacity, maximum.
f. Zero and span drift.	±1% opacity, 30 minutes.
g. Response time...	≤5 seconds.

3.3.2 Smoke meter evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ±5 percent of the nominal rated voltage.

3.3.2.2 Spectral response of photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 9-1.

3.3.2.3 Angle of view. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: $\theta=2\tan^{-1} d/2L$, where θ=total angle of view; d=the sum of the photocell diameter+the diameter of the limiting aperture; and L=the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: $\theta=2\tan^{-1} d/2L$, where θ= total angle of projection; d= the sum of the length of the lamp filament + the diameter of the limiting aperture; and L= the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibarted within ±2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and span drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response time. Determine the response time by producng the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. *References.*

4.1 Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

4.2 Weisburd, Melvin L., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, N.C., APTD-1100, August 1972. pp. 4.1–4.36.

4.3 Condon, E. U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., N.Y., N.Y., 1958, Table 3.1, p. 6–52.

FIGURE 9-1
RECORD OF VISUAL DETERMINATION OF OPACITY

PAGE___of___

COMPANY____________________
LOCATION____________________
TEST NUMBER____________________
DATE____________________
TYPE FACILITY____________________
CONTROL DEVICE____________________

HOURS OF OBSERVATION____________________
OBSERVER____________________
OBSERVER CERTIFICATION DATE____________________
OBSERVER AFFILIATION____________________
POINT OF EMISSIONS____________________
HEIGHT OF DISCHARGE POINT____________________

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CLOCK TIME	Initial			Final
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start--End	Sum	Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

FIGURE 9-2 OBSERVATION RECORD

PAGE ___ OF ___

COMPANY ____________
LOCATION ____________
TEST NUMBER ____________
DATE ____________

OBSERVER ____________
TYPE FACILITY ____________
POINT OF EMISSIONS ____________

		Seconds				STEAM PLUME (check if applicable)		
Hr.	Min.	0	15	30	45	Attached	Detached	COMMENTS
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							
	29							

FIGURE 9-2 OBSERVATION RECORD
(Continued)

PAGE ___ OF ___

COMPANY ____________
LOCATION ____________
TEST NUMBER ____________
DATE ____________

OBSERVER ____________
TYPE FACILITY ____________
POINT OF EMISSIONS ____________

		Seconds				STEAM PLUME (check if applicable)		
Hr.	Min.	0	15	30	45	Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
	41							
	42							
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	59							

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